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FOR ENGINEERS AND CONTRACTORS CONTROLLING THE DESIGN, SPECIFICATION, INSTALLATION AND MAINTENANCE OF HEATING, VENTILATING AND AIR CONDITIONING.

HEATING & VENTILATING
AIR CONDITIONING

FOR APRIL, 1940

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Photograph on cover shows the Hollywood Studio of the National Broadcasting Company, New York.

IN THIS ISSUE:

LARGEST RADIO STUDIO

An important feature in air conditioning any radio studio is the control of sound. In the Hollywood Studio of the National Broadcasting Company, which, incidentally, is the largest building ever erected for radio broadcasting, elaborate methods of accomplishing sound control were used. For complete details of the sound control system and other features of the air conditioning system, see page 15.

HARVARD CUTS HEATING COSTS

Harvard University some time ago inaugurated a highly successful program designed to reduce its heating costs. Savings as much as 55% were the result of this program. For detailed description of just how these savings were effected, see page 24.

NOISE ELIMINATION

The reduction of noise in air conditioning systems is a problem of great importance to everyone dealing with the design or installation of such systems. Starting on page 20 is a very practical article which discusses the fundamentals of this subject and tells just how to keep the noise down to safe levels.

PROFITS IN AIR

Heading the Profits in Air section this month is an article which describes the 1800-ton air conditioning system installed in the Painesville plant of the Industrial Rayon Corporation, which manufactures a new type of rayon yarn. In another article is described a chemical air drying installation in a plant which manufactures dental anesthetics. Also included is a second part of a series of articles on dust control in industry. This article discusses pipe velocities for conveying dust, and types of dust filters.

DEBUNKING PIPING PRACTICE

This is the first of a series of articles which will show that many piping practices which have been followed in the past are now obsolete and considerable savings can be made by violating these so-called standard hook-ups. This month, the author shows up some of the fallacies in the recommended hook-ups for connections to mains.

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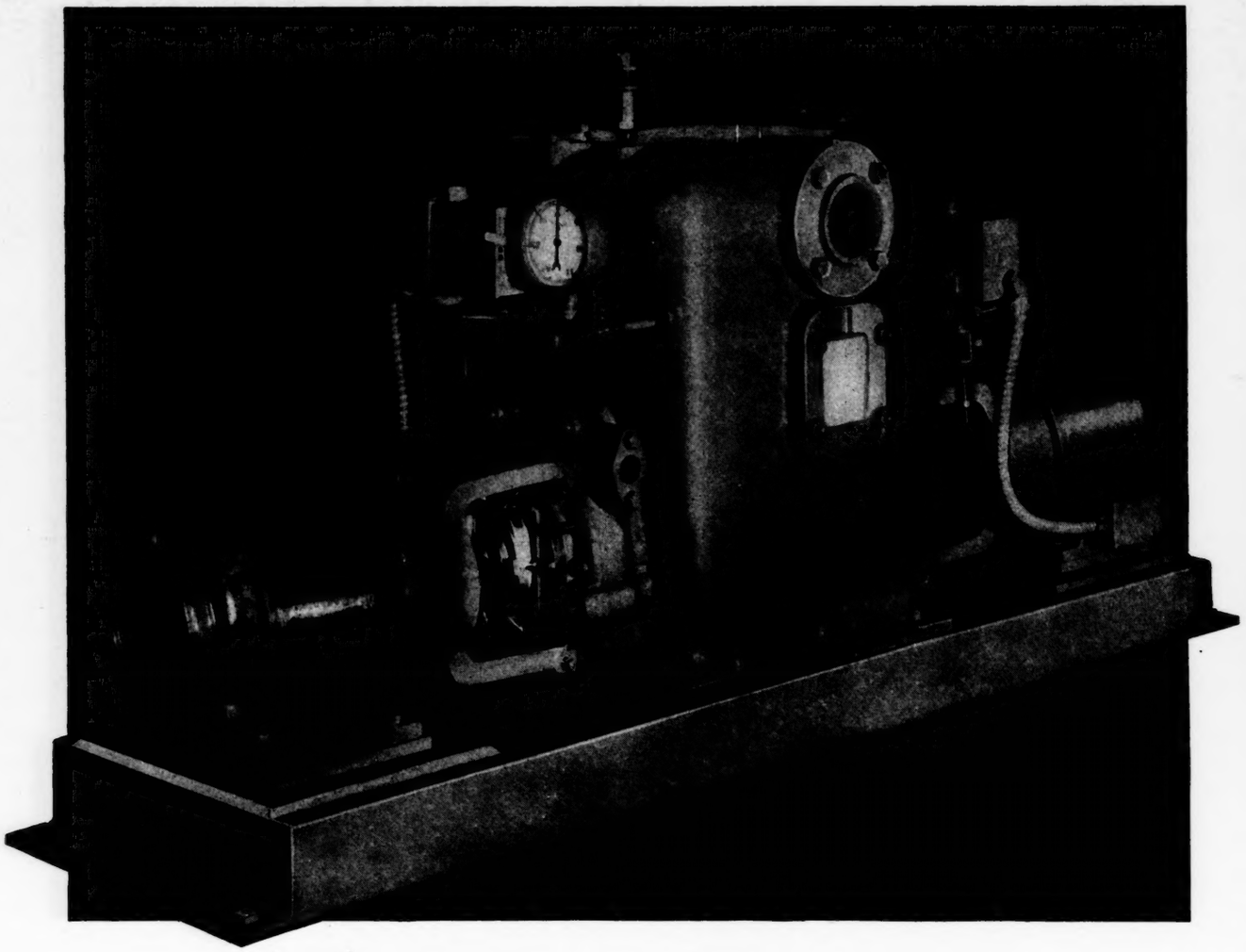

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THE NASH ENGINEERING COMPANY

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1 **LARGEST BUILDING** ever erected exclusively for radio broadcasting—the Hollywood Studio of the National Broadcasting Company. In addition to eight studios more than 100 offices and rooms are provided in the three-story section.

Radio Studio Air Conditioning Plant Approaches Ultimate in Sound Control

By CLIFFORD STROCK†

To a far greater extent than in any other type of building sound must be controlled in a radio broadcasting studio. In the new NBC studio in Hollywood, the elaborate methods of accomplishing this sound control include a comprehensive scheme of lining and wrapping the air conditioning ducts and sound isolation of the apparatus. This super broadcasting layout was designed by O. B. Hanson, NBC Vice President and Chief Engineer, in cooperation with The Austin Company, with the air conditioning the joint achievement of NBC, Austin, and Western Air & Refrigeration, Inc.

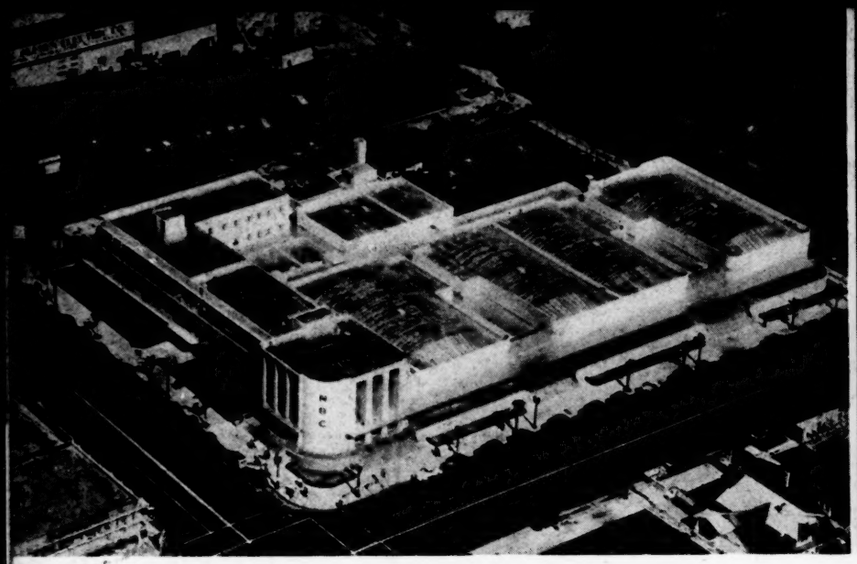
BUILT into the Hollywood Studio of the National Broadcasting Company, opened early last year, is the combined experience of the engineers of National Broadcasting Company in sound transmission and control, that of the engineers and architects of The Austin Company, one of the country's leading industrial plant builders, and that of Western Air & Refrigeration, Inc., air conditioning engineers and contractors.

The problem faced by a designer of broadcasting studios is a highly specialized one. In the case of the Hollywood Studio the problem was further complicated by the fact that no less than eight studios are provided in this two-million-dollar layout, by far the most modern plant so far constructed for radio broadcasting.

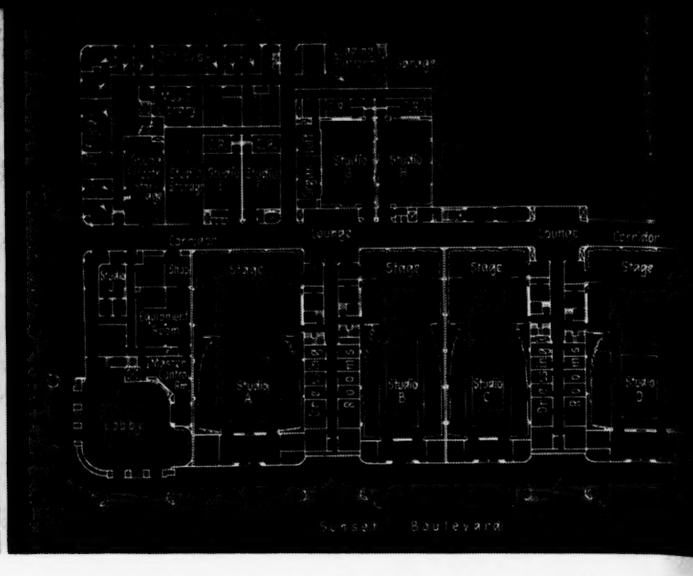
Each of the four spacious, 340-seat theater studios and the four smaller studios, has its own entrance foyer, sound stage, and artists' dressing rooms. Each studio has been constructed as an individual unit with its own foundation and completely isolated from all other parts of structure. Really eight separate structures wrapped in one, this Radio City of the West has curved walls of tinted blue and green (to reduce glare), linked by glistening panels of glass block which screen two backstage corridors between the four large studios and rise to great height above the entrances to the lofty, 3-story lobby. See Fig. 1.

The studio is located on a 4½-acre plot at Sunset and Vine, Hollywood. The walls are of 8-in. concrete. In-

†Associate Editor, HEATING & VENTILATING.



2 **ALUMINUM** paint on the roof serves to reduce sun heat transmission. Building is of concrete which is tinted with reds and blue-greens.



3 **PLAN** of the first floor of the NBC Hollywood Studio. There are 4 large studios, 2 intermediate size studios, and 3 small studios.

terior finish, where not plastered directly on concrete, consists of wood stud furring which is isolated on felt clips where sound transmission is a factor. Due to the area limitations of this type of building construction and also isolation requirements for sound transmission between studios, the building as a whole is subdivided into eight separate units by double concrete walls.

These walls are separated by air spaces carried down to separated footings and have no solid contacts at any place. This separation of footings where the walls were so close together necessitated considerable engineering detail to prevent the normal footing pads from touching. This was accomplished by picking up wall panels on beams and carrying them to isolated pads, straddled in turn by other beams to other pads.

Where necessary to frame concrete floors to such walls the floor is carried on a concrete bracket to the wall, but resting on a bed of isolation cork so shaped as to give not only vertical support but lateral resistance to seismic loads. Where such floors are on grade they are separated by a half inch of mastic.

In the organ studio under which is a basement, the finished floor is floated on the structural floor by the use of spring isolators, as well as furring out the walls by the use of similar spring isolators.

Access to all studios is through sound-locks, vestibules with doors closing to rubber strips at head and jamb, and movable rubber strip at bottom which is forced down to contact the saddle when the door is closed.

The roof is a wood bowstring type truss with wood roof rafters, 1 inch wood roof sheathing covered with 1 inch insulation board, composition roofing, and finally a spray coating of aluminum paint to reduce solar heat gains. This aluminum paint can be seen in Fig. 2.

The general layout of the first floor is shown in Fig. 3 and the layout of a typical studio in Fig. 12, while the modern appearance of a typical assembly room of one of the larger studios is illustrated in Fig. 9.

In addition to the air conditioning systems, described later, there are four exhaust systems. One system takes care of miscellaneous rooms not otherwise ventilated and which are located along the north wall of the building; the second system serves the basement rooms in the northwest portion of the building; a third provides for the PBX and telephone rooms on the second floor, and the fourth serves the toilets along the south wall.

Two gas-fired steel boilers (Fig. 5), with provision for a third, have been installed to furnish steam for the vacuum heating system. The steam mains to the individual indirect heating coils, direct radiators, and unit ventilators, are of steel, while the vacuum return lines are copper tube. Individual cabinet type convectors are installed in all outside rooms and general offices and two unit ventilators heat and ventilate the main entrance lobby.

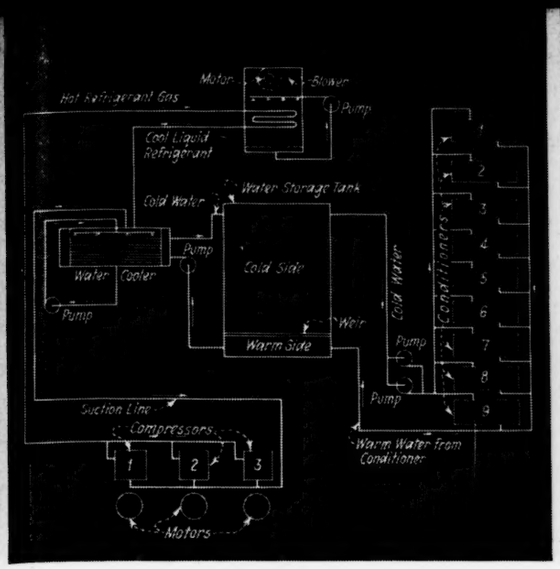
The dry bulb temperature throughout the conditioned spaces is kept at 72F during periods when heating is required, while during warm weather a dry bulb temperature of from 10 to 15F below that outside is maintained, with the relative humidity kept constant at 45% throughout the year.

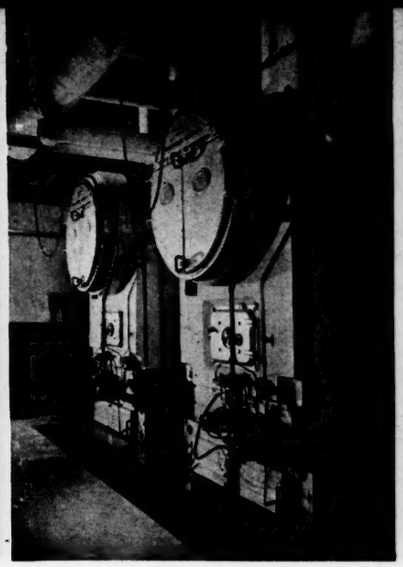
In order to reduce the possibility of any air-borne sounds being carried through the ducts from one studio to another the engineers have provided nine separate air conditioning systems. Five of these serve the broadcasting studios and their control rooms, while four other systems serve the corridors, dressing rooms, clients' audition rooms and executive offices. Since no smoking is allowed in the studios, the air can be recirculated in the systems serving those areas but from all other spaces, where smoking is allowed, no air is recirculated.

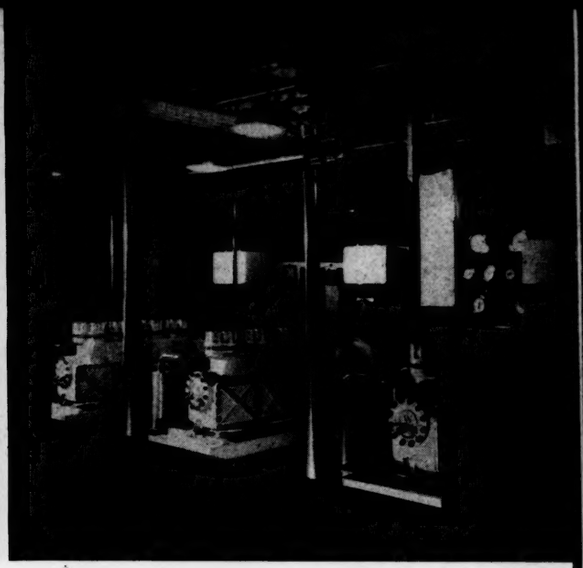
Since Studio B is typical of the larger studios, the air conditioning system for that studio is here described and illustrated to show the general method adopted.

An elevation of the recirculating air conditioning system serving Studio B is shown in Fig. 10. Return air enters through a tunnel, lower right. Excess air is blown to exhaust through the duct at the left, while outside air is drawn in through the overhead duct at the right. The mixture passes through the dry filters, thence through the chilled water coils and finally through the supply fan at the right.

The ducts connected to the conditioner B are shown in Fig. 11. This drawing shows the location of the conditioner and the supply ducts leading to the assembly room and stage, and also indicates, under the front of the stage, the return air plenum. This plenum has been thoroughly sound insulated with 1-in. balsam wool lining and with a sound baffle immediately following the



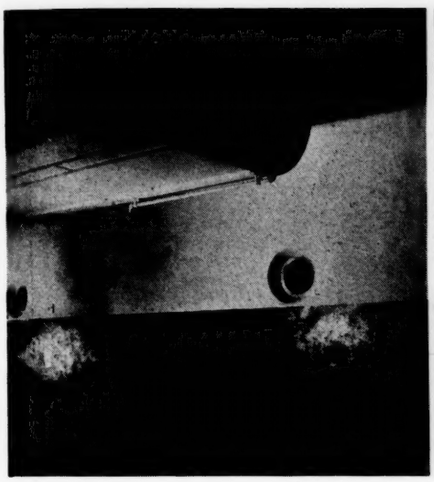


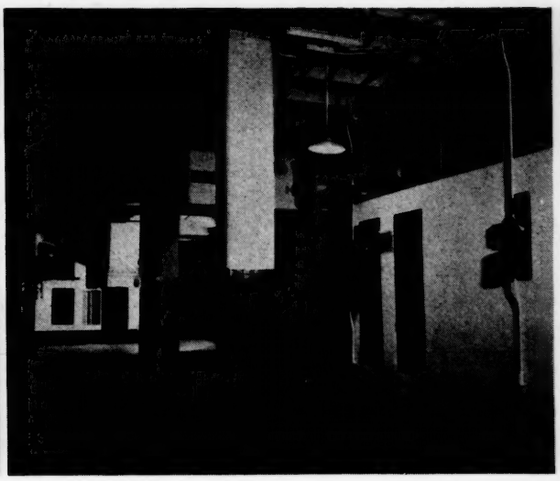


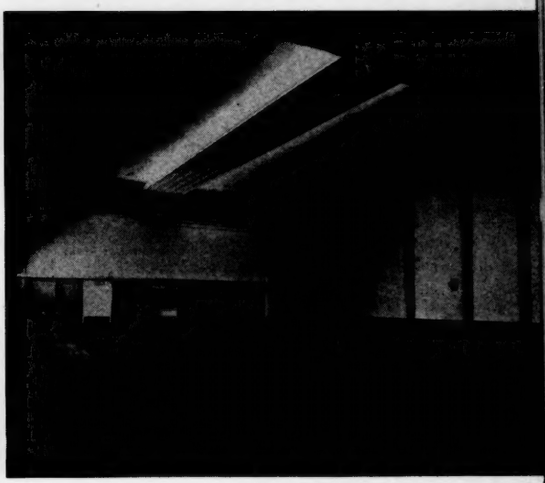
4 **HOOK-UP** of refrigeration equipment supplying the nine air conditioning units. An 85,000 gal. chilled water tank and three 49-ton compressors give the plant a peak capacity of 240 tons. Note use of separate refrigerant pump on water cooler.

5 **BOILERS** of the gas-fired type supply steam to the vacuum heating system. Steam mains are steel while vacuum return mains are of copper tube. Convectors and unit ventilators are used for heating.

6 **COMPRESSORS** as seen through visitors observation window. Each compressor has a capacity of 49 tons and supplies high pressure Freon to an evaporative type condenser on the garage roof. Liquid refrigerant from evaporative condenser goes to water cooler.





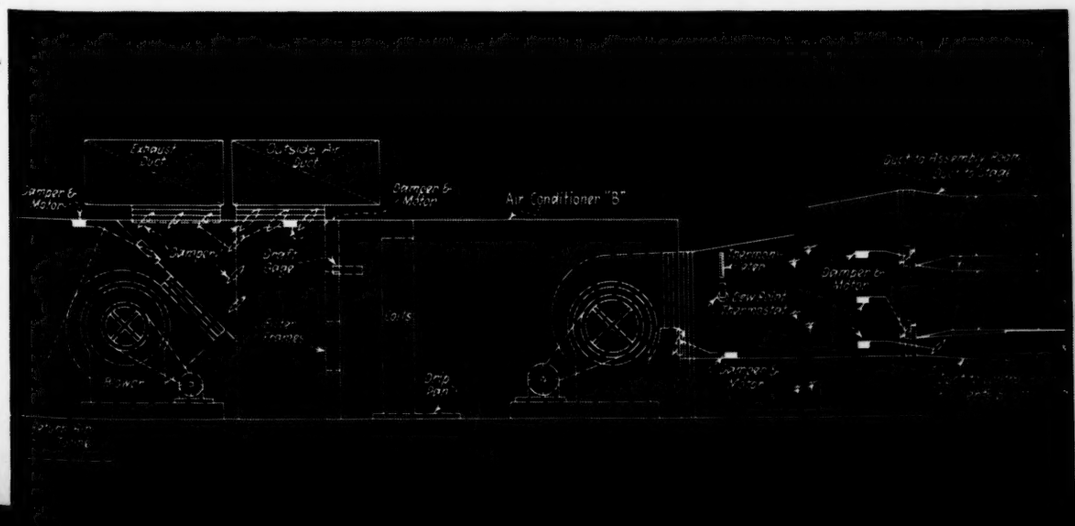


7 **PORT** holes inside of 85,000 gal. chilled water storage tank show maintenance engineers condition of tank. Cooled water is stored in this tank during off-peak periods. Two chilled water pumps circulate this water to air conditioning units.

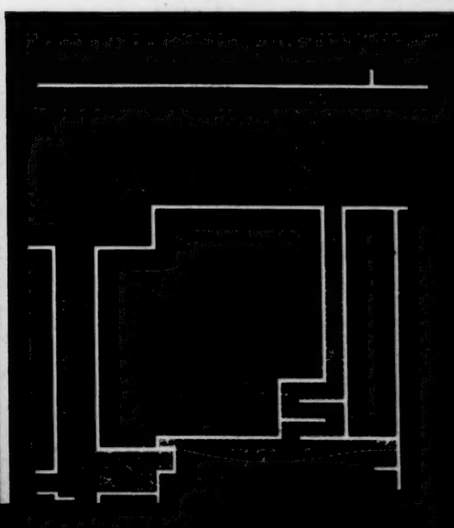
8 **AIR** conditioning units are located in the basement and serve 9 separate systems. 5 are employed for conditioning broadcasting studios and control rooms, while 4 serve the corridors, dressing rooms, and offices. No air is recirculated by the systems which serve spaces in which smoking is allowed.

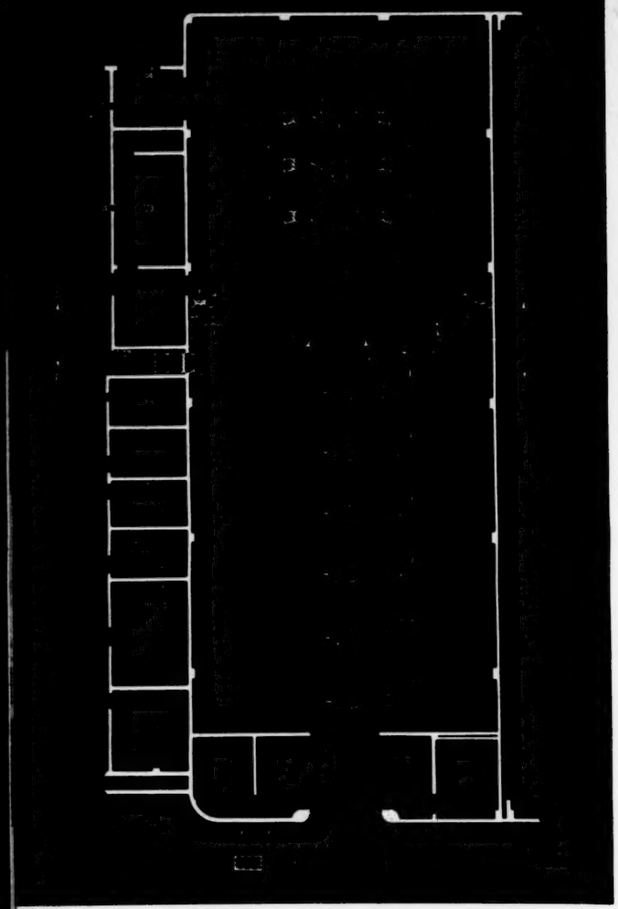
9 **STUDIO B** seating 340 persons is typical of the larger studios. 72F is maintained in these studios when heating is required while 10 to 15F lower than outside temperature is maintained during warm weather. Relative humidity is kept at 45% the year round.

10 **AIR** conditioning unit serving Studio B. Return air enters through the tunnel at the lower right and is mixed with outside air which comes in through the duct at the top of the unit. Exhaust air duct serves to carry all excess air from system. Mixture of air passes through dry filters, chilled water coils, and finally through supply fan at right. A dewpoint thermostat controls the leading conditions from the air. Dampers in the main duct and in the exhaust and outside air ducts are all interconnected. The dampers adjacent to the fan outlet control the air pressure in the ducts.

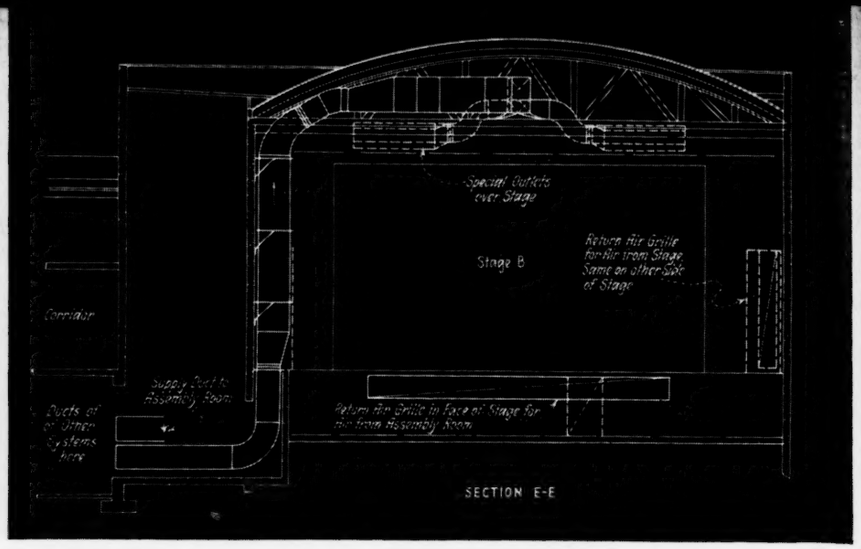


11 **DUCTWORK** connecting conditioner B with Studio B. Shown here is the location of the conditioner and the supply duct leading to the assembly room and stage as well as the return air plenum over the front of the stage.

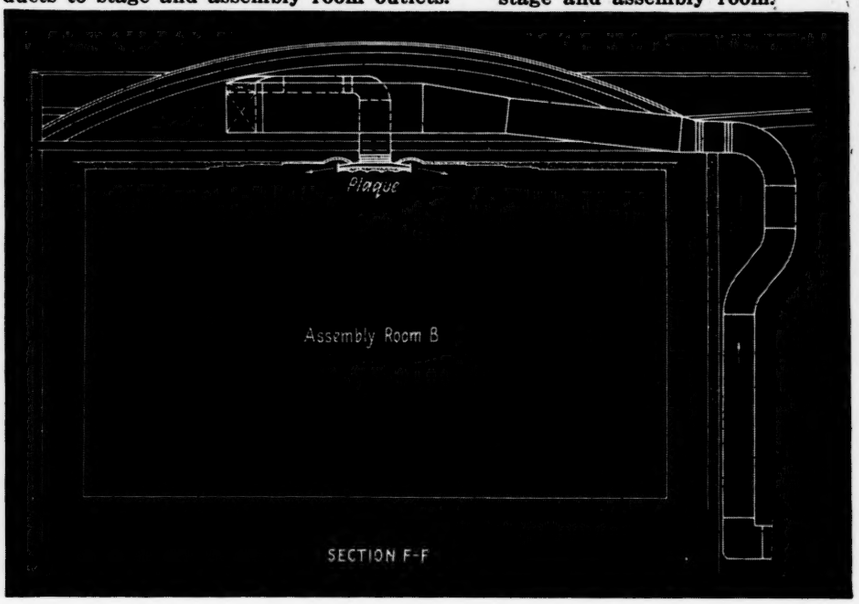




←12 **PLAN** of Studio B showing connecting duct work. All supply air is delivered from the basement to the first floor at one point. From the risers, air is carried through ducts to stage and assembly room outlets.

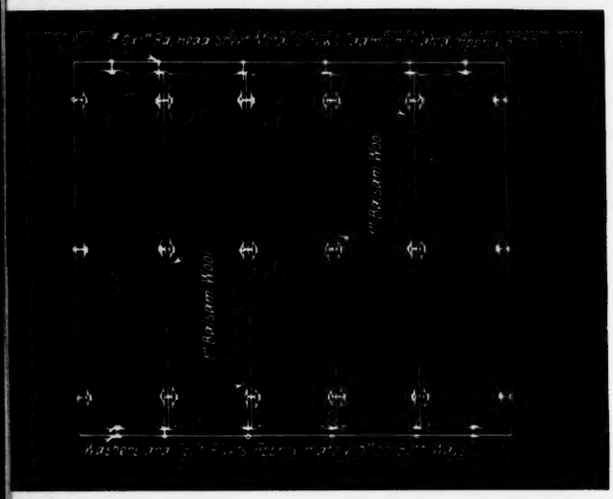

Special Outlets over Stage
Stage B
Return Air Grille for Air from Stage Same on other Side of Stage
Corridor
Supply Duct to Assembly Room
Ducts of Other Systems here
Return Air Grille in Face of Stage for Air from Assembly Room
SECTION E-E

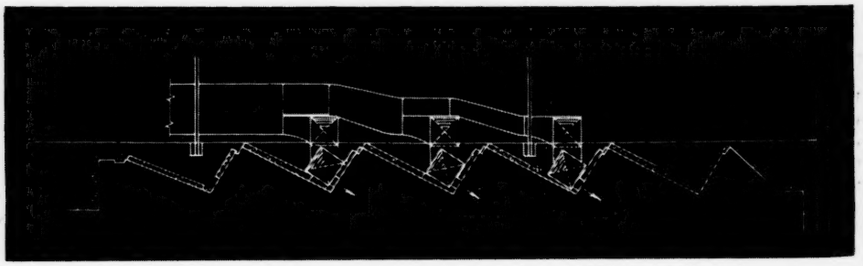
↑13 **AIR** supply system arrangement serving the stage of Studio B and the return air arrangement serving both stage and assembly room.



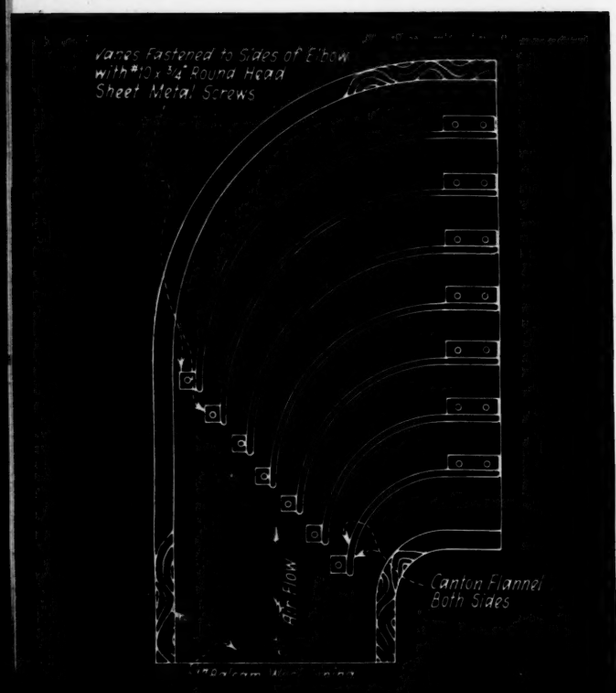
↑14 **ASSEMBLY** room portion of Studio B is served by a continuous plaque connected to the supply duct with a canvas collar. This is typical of all of the larger studios.

←15 **SOUND** absorber section is shown here. This section is located in the return air duct just after the sound baffle, as indicated in Fig. 11. Section is divided into vertical channels by metal strips covered with balsam wool.



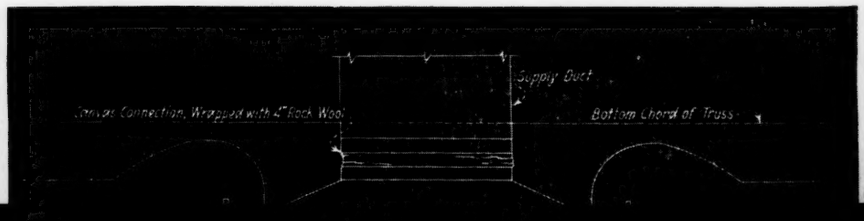


↑16 **METHOD** of introducing supply air is shown by this section taken through the ceiling of the stage in Studio B. These outlets throw air towards the back of the stage.



←17 **ELBOW,** section of which is shown, is used to connect the supply duct to the continuous plaque outlet in the ceiling of the assembly room. Six of these are used in each of the four large studios.

↓18 **CONTINUOUS** plaque cross section is shown here. This plaque is connected to supply duct with a canvas connection wrapped with 4-in. of rock-wool.



plenum. After the sound baffle the air passes through a 16-ft. section of the duct treated to act as a sound absorber. This section is divided into vertical channels by sheet metal strips which are covered on both sides with 1 in. of balsam wool, as shown in Fig. 15.

All of the supply air is delivered from the basement to the first floor at one point, as shown in Fig. 12. From the risers the air is carried through overhead ducts to the stage and assembly room outlets, as shown in Fig. 12. As indicated on this drawing, all ducts are wrapped with ½ in. of rock wool except where indicated by cross hatching, where 1 in. of balsam wool lining is provided in addition to the ½ in. of rock wool wrapping.

Details of air distribution in both the assembly room and the stage are of special interest. In the case of the stage, six special outlets are provided as shown in plan in Fig. 12 and in elevation in Fig. 13; these outlets blow the air downward toward the back of the stage, as indicated in Fig. 16.

In the assembly room, six outlets from the supply main are distributed longitudinally. See Fig. 12. Air to these outlets from the main passes through a special elbow (Fig. 17) lined with balsam wool and whose vanes are insulated with canton flannel. This air is fed into the room through a continuous plaque, shown in Figs. 14 and 18, fastened to the supply duct with a canvas connection and wrapped with rock wool. The appearance of this plaque can be seen in Fig. 9.

All of the foregoing illustrates the careful precautions taken to insulate sound. All of the other air conditioning systems are similarly equipped with sound absorbers in supply and return ducts and in the apparatus casings. Most of the ductwork is insulated inside and out. Canvas connections have been made between sheet metal ducts and fans and wherever these ducts pass through building walls to prevent the transmission of vibration noises. In addition, all fans, motors, pumps, air compressors and vacuum pumps are installed on vibration absorbing bases. The refrigerating compressors are installed on isolated concrete bases.

Cooling is provided by three 40-ton Freon compressors installed in the basement under Studio G, which has isolated walls and ceilings. The refrigerant is sprayed over the tubes of a horizontal spray type shell and tube water cooler which is located in the apparatus room and which is connected to a chilled water storage tank of 85,000 gallons capacity located under Studio H. The arrangement is shown in Fig. 4.

During off peak periods the cooled water is stored so that during peak periods the combined capacity of the cold water storage tanks and the 120 tons of compressor capacity give a peak capacity of 240 tons. An evaporative type condenser is installed on the roof of the garage connected to the water cooler and compressors by welded steel refrigerant lines. The refrigeration system includes accessories such as an oil separating device, Freon filter, dehydrators, automatic controls and a refrigerant recirculating pump.

The cold water circulating system includes two cold water pumps for circulating water to the nine individual cooling and dehumidifying systems. The two circulating pumps are connected in parallel so that either or both of the pumps can be used for circulating water to the various air conditioning systems. The entire cold water system is so designed that any one of the air conditioning units can be run independently.

19 **RECEPTION** room in one of the offices, showing rosette type air supply inlet in ceiling.

An electrical temperature indicating system is installed with twenty indicating points. Nineteen of these points are located in the different conditioned areas and the twentieth point is located in the cold water reservoir. The temperature indicating system is of the remote type and the indicator is located in the engineer's office.

The method of control of the refrigeration system is as follows: A thermostat is located in the cold side of the cold water storage tank to start the cooler circulating pump when the water temperature in the storage tank rises above a predetermined setting. When the cooler pump is started it energizes a relay and a contactor which starts the refrigerant pump, the three compressors, and the evaporative condenser fan. In case all three compressors cut out, a pressure switch will stop the refrigerant pump so that it cannot run dry. The evaporative condenser pump is started by the evaporative condenser fan by means of a relay.

A float check maintains a set liquid level in the water cooler. A thermostat located in the water line on the leaving side of the cooler shuts off all compressors, the refrigerant pump, and the evaporative condenser fan and pump if the water temperature approaches freezing for any reason—thus preventing damage to the cooler. A pressure switch is provided to accomplish the same purpose in case the circulating pump loses its prime.

The number 1 compressor is started and stopped with the cooler circulating pump, while compressors 2 and 3 are each governed by its own thermostat. These thermostats are located in the water line on the leaving side of the cooler and are set at different temperatures. Should number 1 compressor not be capable of maintaining the desired temperature, then number 2 compressor will automatically start up, and if the temperature still rises, then number 3 compressor will start and operate until the required temperature is reached.

The cooler pump circulates 600 g.p.m. from the sump on the warm side of the tank through the cooler to a concrete box on the cold side. The two-coil circulating pumps circulate the water from the concrete box through the coils to the warm side in quantities depending on the demand.

How to Use Sound-Absorbing Materials in Air Conditioning Equipment

By PAUL H. GEIGER†

ALTHOUGH the problem of quieting any given type of machine requires a more or less individual solution, there are certain principles and techniques which prove useful on almost every machine noise problem. There are four general methods of quieting a machine; these are

1. Absorption of air borne sounds,
2. Damping of vibrations,
3. Isolation of vibrations, and
4. Reduction of the sound at the source.

Each of the first three of the methods listed requires a special type of material to accomplish the desired purpose. In general a material which is suitable for one of these purposes is poor for either of the other two. For example, steel springs of the proper design are extremely effective for isolating vibrations, but they will give practically no damping and of course will not absorb air borne sounds. Materials designed for absorbing air borne sounds are not very effective either for damping out vibrations or for preventing their transmission from one part of the machine to the other. Rubber can be used efficiently for the isolation of vibrations and at the same time will furnish some damping, but usually any necessary damping may be furnished by other means at a lower cost.

The object of this article is to point out how sound absorbing material may be used to the best advantage. In an article to be published in the next issue, the other means of quieting will be discussed. Ways of determining which method, or methods, of quieting need be used, will be described briefly.

Absorption of Air Borne Sounds

One of the most familiar types of material used for noise reduction is sound absorbing material; this is supplied in several forms, such as blankets, semi-rigid boards, tiles, plaster, and in various granulated and fibrous shapes. All these materials are characterized by being more or less porous. Their function is to absorb air borne sounds. When a sound wave strikes such a material a portion of the sound is absorbed by the material, due either to the frictional losses produced by the motion of the air in the air spaces of the material or by frictional losses due to slight movement of the material itself.

If a source of sound is placed in an inclosure, the sound level therein will depend upon the nature of the walls. When the sound source is started, the loudness will keep increasing until the value is reached where the sound energy is lost by absorption at the same rate that it is being produced by the source. If the walls of the inclosure are highly reflective (for sound), the sound level will build up to a high value. If, on the other hand, some sound absorbing material is present, the equilibrium state will exist at a lower sound level. Fig. 1 shows how the noise made by a machine inside an inclosure decreases as sound absorbing materials are added. For the purposes of illustration, the curve was computed for a machine in a cubical, thick sheet steel case, three feet on a side. There would be about one unit[1] of sound absorption in such a case. The addition of another unit of absorption decreases the loudness by 24%, but after a few units are used, the decrease in loudness due to the addition of more absorption is much less. It is evident then that it is not economically feasible to attempt to obtain an extreme amount of quieting solely by means of sound absorbing material. The example selected for Fig. 1 is an extreme case, for the initial point on the curve represents the extremely small amount of absorption existing in an unlined, reinforced sheet steel box. In many cases sound absorption is already present in parts of the machine or in the nearby surroundings, so that conditions are already such that they are represented by a point well down on the flat portion of the curve, and so a large amount of absorption will be needed to make a noticeable decrease in noise. Such a condition exists in automobile bodies. The upholstery, head lining, trim, and carpet offer so much absorption that it is often questionable whether it is worth while to add any material for the sole purpose of obtaining additional absorption.[2] In the case of one automobile tested, the addition of two-inch thick sound-absorbing material over the floor, roof, dash, seats, and in the luggage compartment reduced noise by only 8% from what it was when the car was stripped of all materials used solely for quieting purposes. In quieting offices, or other rooms, it is usually considered too expensive to attempt more than a 40 or 50% reduction in loudness.[3]

Fig. 1 was computed to show the change in loudness inside an inclosure in which the amount of sound absorption was varied. Since an addition of absorbing material decreases the noise inside, the noise outside will also be decreased to a corresponding extent, provided that the walls of the container are not, in themselves, the source of sound. Taking for an example a compressor mounted in a cabinet, the noise outside the

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[1]A unit of sound absorption is obtained with one square foot of material which will absorp 100% of the sound which strikes it. A given piece of material gives a number of units of absorption equal to the product of its absorption coefficient and its area in square feet.

[2]This statement is not meant to include materials used to damp out vibrations in the body panels.

[3]The American Standards Association Loudness scale will be used in this paper to express loudness values. This scale is preferred to the decibel scale because it agrees with the way the average observer judges loudness.

cabinet will decrease substantially as shown in Fig. 1, provided the compressor is properly isolated from the cabinet. In case the compressor is rigidly bolted to a portion of the cabinet, addition of absorbing material inside the cabinet will not appreciably reduce the noise outside because vibrations from the source are conducted directly to the walls which in turn radiate the sound. In case the compressor is properly isolated, the vibration in the surfaces of the cabinet is set up mostly by air borne sound, so when absorbing material is added inside, the noise outside is reduced, not because the addition of absorbing material on the walls of the cabinet reduces the transmission, but because there is less sound to be transmitted. A sound absorbing material is comparatively ineffective in preventing the transmission of air borne sound.

The selection of the most economic type of sound absorbing material for a given purpose is made easy by the use of laboratory tests on the material. These measurements give the sound absorption coefficient of the material; this coefficient is equal to the fraction of sound energy which is absorbed each time a sound wave strikes the material. A perfect sound absorber, that is one which would absorb 100% of the sound energy incident upon it, would have a coefficient of 1.00. Some materials have coefficients approaching this value.

The sound absorption coefficients of some typical materials are given in Table 1. These figures represent average values of materials of different manufacture. Although similar materials made by different manufacturers will differ somewhat, the figures given in the table, except for acoustic plaster, are fairly representative and are accurate enough for most noise reduction work. The coefficients of acoustic plasters differ greatly, so it will be necessary to obtain data from the manufacturers. More complete tables of absorption coefficients may be found in "Acoustics and Architecture" by P. E. Sabine and "Architectural Acoustics" by V. O. Knudsen. The tables in the latter are unusually complete.

As shown in the table, the sound absorption coefficient of a given material is different for different frequencies (pitches). For a majority of materials the coefficient is low for low frequencies and high for high frequencies. If the thickness of a material is increased, the absorption at very low frequencies is increased roughly proportionally to the thickness; at higher frequencies it will also be increased but by a smaller amount. Since the Coefficient vs. Frequency curves of different materials are by no means parallel, a material should be selected which offers the maximum absorption per unit of cost for sounds of frequency corresponding to the loudest of the noise components in the machine to be quieted. A judgment of the frequencies present in the noise can be roughly determined by ear, remembering that the musical pitch of middle C corresponds to a frequency of about 260 cycles per second, and that each octave above that corresponds to a doubling of the frequency. A sound analysis made by a sound analyzer or by band pass filters would of course give results which would not be subject to errors as are judgments made by ear.

TABLE 1—SOUND ABSORPTION COEFFICIENTS OF TYPICAL MATERIALS

Material	Coefficient for Sounds of Frequency			
	256	512	1024	2048
0.5" Jute felt	0.10	0.20	0.45	0.55
1.0" Jute felt	0.19	0.50	0.55	0.60
2.0" Jute felt	0.40	0.65	0.70	0.70
1.0" Hair felt	0.35	0.55	0.80	0.85
1" Wood fibre blanket	0.25	0.50	0.60	0.65
0.5" Fibre board as used for plaster base	0.22	0.28	0.30	0.28
1.25" Acoustic fibre board	0.36	0.70	0.80	0.80
1" Felted Mineral wool	0.40	0.55	0.70	0.75
Acoustic plaster	0.30	0.30	0.32	0.44
4" Granulated Mineral wool	0.50	0.58	0.63	0.65
Wood, unpainted	0.08	0.10	0.09	0.08

Low Frequency Sounds

The presence of a low frequency component in the noise of a machine calls for an absorbing material which has very good absorption for low frequencies. This means a thick, and therefore comparatively expensive,

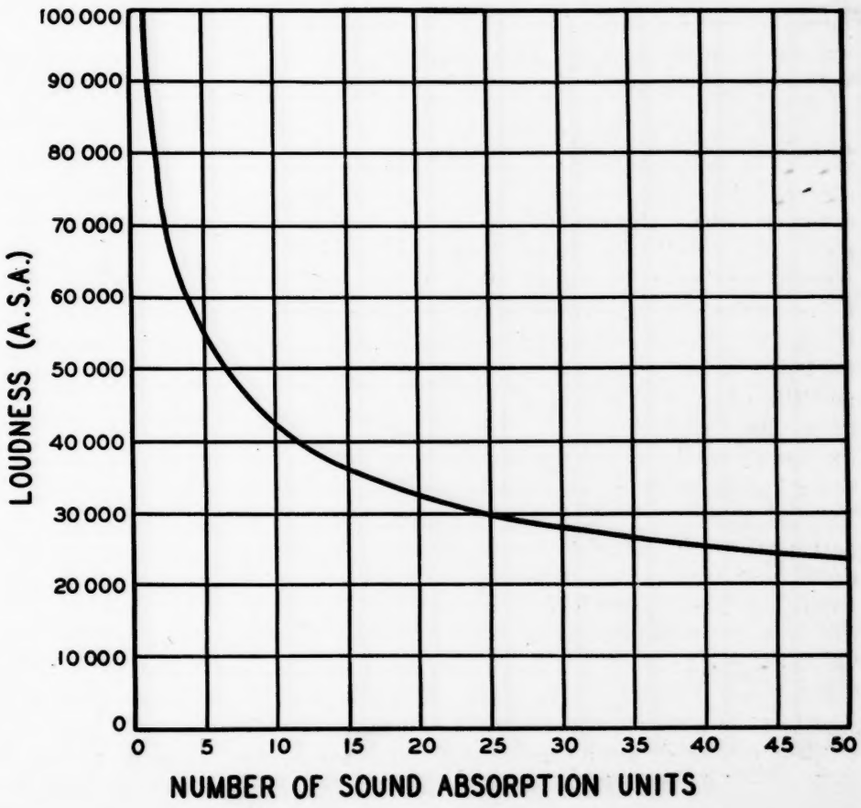
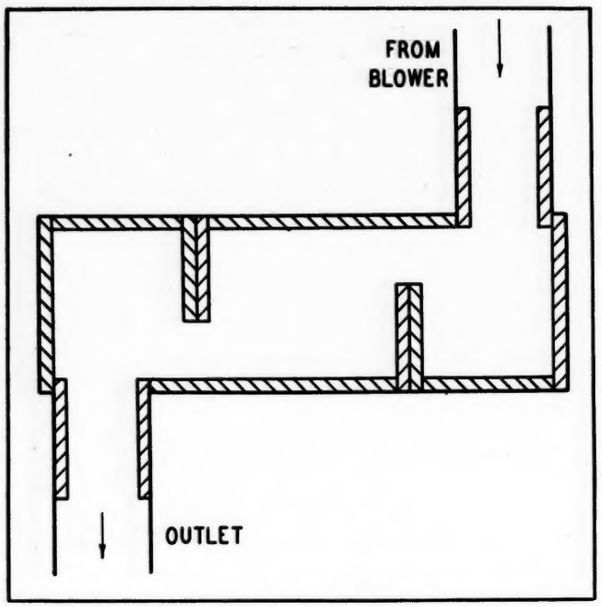


Fig. 1. Change in loudness brought about by change in amount of sound absorbing material.



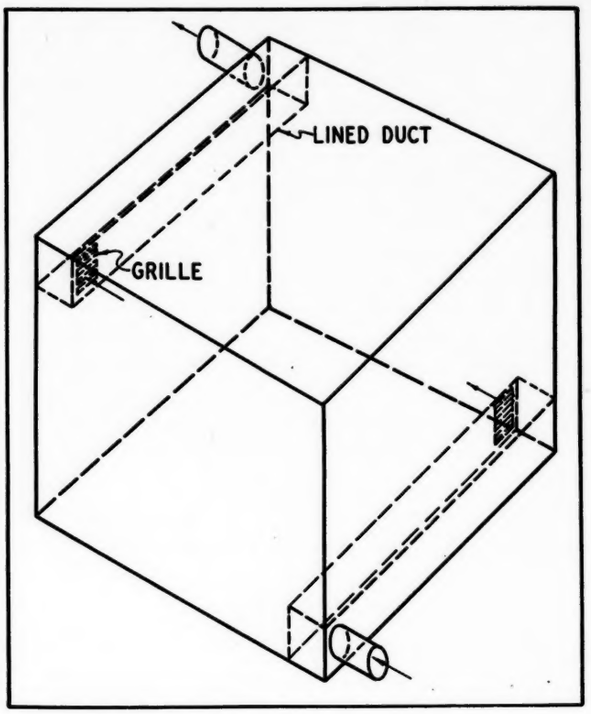


Fig. 2. (Above) Sound trap for air-borne sounds.
Fig. 3. (Right) Ventilation of sound-proof room.

material. However it is sometimes possible to design an absorbing structure which is effective in absorbing sounds of a particular frequency and which uses somewhat less material. Such a construction will probably only be advisable on machines made in large enough quantities so that the savings of a few cents per machine will amount to enough to justify the cost of the development work.

Placement of Material

Since sound absorbing material is effective in absorbing air borne sounds, it should be placed where the sounds are the loudest. Since there is very little loss of sound energy in transmission through air, the loudness of a sound is substantially the same at any place inside an inclosure, except at locations close to the source of the sound. In an ordinary room it makes little difference where absorbing material is placed, whether on the floor, walls, or ceiling. However in the case of air conditioning equipment we often wish to confine the noise to the small inclosure in which the machine is placed. In this case it is advisable to use the material in close proximity to the source of the sound. Fortunately sound absorbing material is very effective in reducing the transmission of sound through the air in ducts. Since the velocity of sound in air (66,000 ft. per min.) is much greater than that attained by air flow in ducts used in air conditioning, sound can travel as well through the inlet ducts as through the outlet ducts, so provisions must be made to prevent sound from traveling over both these paths.

Use of Bends

A bend in a duct offers a very good position for the efficient use of absorbing material, for the sound will suffer multiple reflection before it can pass down the pipe. In some cases it may be of advantage to introduce changes in the direction of air flow in order to take advantage of the above construction, for very great sound attenuation can be secured by this means with a minimum cost for sound absorbing material. Fig. 2 shows the construction of a sound trap used in an experiment calling for the measurement of the noise made by the passage of very low velocity air through a grille. The air flow was regulated by a constriction at the inlet to the blower, so if this trap had not been used, the blower noise would have been much greater than the noise which it was desired to measure. With the trap in place the blower noise was below audibility. For practical installations a much smaller and simpler construction can of course be used.

The construction similar to that shown in Fig. 2 is quite effective even when the baffles are removed. Similar constructions have been used successfully in a number of cases in the construction of sound test rooms in noisy factories. By forcing the air through lined ducts placed as shown in Fig. 3, satisfactory ventilation can be secured and at the same time remarkable freedom will be had from factory noise.

The above descriptions of sound traps are given merely to illustrate the fact that a comparatively small amount of sound absorbing material can be very effective in preventing the passage of sound through a duct, if placed at a suitable location and in a position such that the sound will suffer many reflections before passing down the duct.

Several efficient sound absorbing materials come in a blanket, or loose fibrous, form. These may be given mechanical protection by a wire screen or by perforated sheet material. Such a cover will change the absorption coefficient only slightly, even though the area of the perforations is only a small fraction of the total area of the material.

Because of the high temperatures and fumes which they are exposed to, quartz fusing operators must be protected by exhaust hoods. How to design such hoods is discussed in this article which was abstracted from the Public Health Reports. The authors are E. C. Riley, Asst. Public Health Engineer, and J. M. Dalla Valle, Passed Asst. Sanitary Engineer, both of the U. S. Public Health Service.

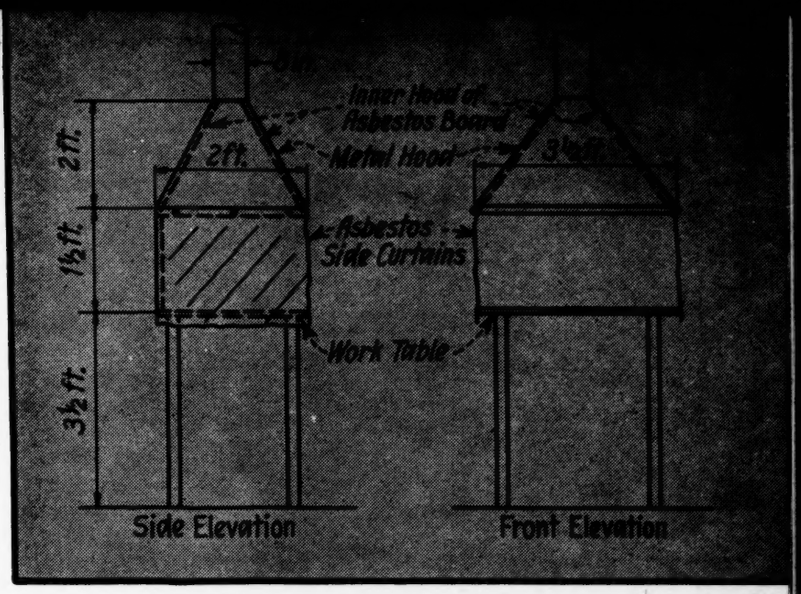


Fig. 1. Hood for fusing quartz objects up to 1 inch diameter.

How to Design Exhaust Hoods for Quartz-Fusing Operations

FUSED quartz apparatus is being used increasingly both in industry and in the laboratory. Its properties, chief among which may be mentioned its ability to transmit ultraviolet light, and its low coefficient of expansion, make it suitable for numerous processes. Fused quartz is blown at temperatures ranging from 2500 to 3000F. Above 3200F quartz volatilizes so rapidly that it is difficult to work. Fused quartz operations require greater skill than glass blowing and have certain undesirable aspects. Operators usually work for a limited time, ranging from two to four hours per day. They complain of a disagreeable odor (caused by quartz fumes), high temperatures, and radiant energy (ultraviolet and infra red), which contribute to fatigue and sometimes cause nausea. To remove these fumes and to prevent high air temperatures exhaust hoods should be provided.

Several important considerations enter into the design of such exhaust hoods. The air temperatures near quartz fusing operations rise rapidly if the enclosure is small and inadequate ventilation is provided. Although water vapor is formed when oxygen and hydrogen are burned, the amount added from this source is small when compared to the amount of heat liberated. If sufficient fresh air is supplied to keep the room air below 100F, the effects of humidity will be negligible. Removal of the heat, radiant and otherwise, is the important problem. A large hood, with asbestos baffles placed inside to intercept some of the radiant heat, and a generous air exhaust, offers a practical solution to the heat and fume problem.

It is estimated that between 300 and 600 B.t.u. per minute are given off by the oxy-hydrogen flame during fusing of a one-inch tube; this rate of energy transfer is the equivalent of about 5 to 10 kilowatts in electrical energy. Nearly all this heat output must be dissipated to the surroundings or removed by the exhaust ventilation. If all the heat were removed by convection in 300 cu. ft. per min. air exhaust, a rise in temperature of 55 — 110F, depending on the rate of fusing, and an outlet temperature of less than 200F, would result under the worst conditions. Actually, much heat is dissipated as radiant energy. Estimates indicate that about one-tenth of the heat supplied is radiated from the fused quartz and in addition there is appreciable radiation from the gases. When the hood surrounds the operation on three sides or more, it intercepts most of the radiant heat which raises the temperature of the walls and thus acts, itself, as a heat source. In order to avoid overheating from either source, it is recommended that large hoods and large air volumes be utilized.

Fig. 1 illustrates the type of hood suggested for the control of quartz fumes and heat. Effective removal of fumes was obtained with average air speeds of 100 ft. per min. at the face of the hood when large volumes were handled. However, to effect greater cooling of the operator, it is recommended that large air volumes be used at relatively low velocity (100 — 200 ft. per min.). The hood suggested is suitable for objects up to 1 in. in diameter. Repeated tests indicate complete removal of silica fumes and little trouble was experienced from hood overheating. The operator also felt considerable relief during work, due to the ventilation.

In view of the possible toxic effects of the fumes and the discomfort occasioned by the excessive heat and fumes, local exhaust ventilation is strongly recommended where quartz is fused. As previously recommended, the hood should be large enough to permit the fusing to be done inside and the burner should be directed into the hood.

TABLE 1—SUGGESTED EXHAUST VENTILATION FOR QUARTZ FUSING OPERATIONS

Diameter of Piece To Be Fused In.	Air Volume Through Exhaust Hood C.F.M.	Air Velocity At Fusing Zone Ft. Per Min.
0.25-0.50	50- 150	100-150
0.50-0.75	150- 300	100-150
0.75-1.00	300- 600	150-200
1.00-1.50	500-1000	150-200

Panoramic view of Harvard University, as seen from across the Charles River

Harvard Makes Savings by Careful Control of Its Heating Systems

By G. K. SAURWEIN†

A GOOD combustion control system is wellnigh indispensable for the economical generation of steam. It is even more important that the steam supply to any given building be controlled in order to accomplish economical heating.

This paper is concerned especially with the heating of a group of buildings by steam supplied from a central boiler plant, as is usually found at an educational institution. In this case the need for control is even greater than ordinary, for what could offer greater opportunity for waste of heat than a connection to a steam main in which constant pressure is maintained at all times? On the other hand, constant pressure steam as available in a central station system is particularly adapted to the application of modern temperature control equipment, resulting in best possible performance of the building heating system.

Put Building System in Good Order

Before installing any temperature controlling equipment the building heating system should be put in good order. Of all the equipment installed in a building, the heating system probably receives less attention than anything else, because it goes on functioning after a fashion even though it has been altered and extended, though there has been sagging of the pipe lines, collection of dirt and corrosion in the lines, worn valves and depreciated traps. With the running down of the system it has become necessary to overheat much of the building to prevent underheating in some parts. Valves should be packed, traps cleaned and repaired, the piping carefully graded and vents put in good order to assure rapid steam circulation throughout the system.

A few means of reducing heat waste should also be mentioned:

1. Weatherstripping of windows and caulking of window frames will greatly reduce excessive infiltration especially with high winds. This, in the opinion of the writer, is probably the most worthwhile investment for saving heat that can be made.
2. Double doors, or revolving doors installed at busy entrances are likewise good investments.
3. Elimination of unnecessary ventilation is important. Ventilating equipment should be so installed that it may be operated at partial capacity with controls conveniently located.
4. Insulate all steam pipes not used as heating surfaces.
5. Determine the temperature required for the particular occupancy of the building or parts thereof and regulate the heating accordingly. The temperature in a store room or shop, for example, need not be as high as that for an infirmary ward.
6. Provide thermometers, gauges, and pressure recorders to enable the operators to operate the system with full knowledge of what is being accomplished.
7. Parts of a building requiring long time or all night heating should be equipped with separate steam lines. This will be much more economical than heating the whole building all night.
8. Make valves accessible and easy to operate, otherwise they will not be used to full advantage.
9. The heating system should be kept in good repair.

†Superintendent of Engineering Department, Harvard University.

Worn, damaged or defective valves or traps, or poor air elimination will result in wasteful performance.

10. Investigate each complaint of "no heat" by occupants; determine the reason and remedy the condition. Do not overheat the entire building to satisfy an occupant in a single room.
11. Vent openings in roof or walls should be closed whenever possible, for the heated air escaping there is replaced by cold air from outdoors.

Automatic Controls

There are several methods of control and the one best suited to a given building will depend on the size and arrangement of the building, the type of heating system installed, and the character of service required.

First cost is a major consideration, and the cost must be justified by the quality of service and the economy produced. Obviously, it would be unwise to make a substantial investment if the expected savings are so small as to require many years for its retirement. Another thought to be kept in mind is this: while sizable economy may be attained with simple equipment at low cost, further gains are more difficult and more costly to reach, and the last increment of possible gain is very expensive and often cannot be justified.

Furthermore, present heating systems with their controls should not be assigned too long a life. The active interest and development now manifested in the field of air conditioning may before long render obsolete much of the equipment now in use. This has happened before right here in our own yard where fireplace heating gave way to stoves, and these to steam radiators.

A number of factors affect the heat loss from a building, the more important being outdoor temperature, wind direction and velocity, and sunshine. It is worthwhile to zone the heating system of a large building (say, over 500,000 cu. ft.) and to control the steam supply to the radiation on the sun-exposed side or sides separately from the other parts of it.

The ideal or perfect heat control should be so designed that the heat supply to the building is adjusted to every change of outside temperature, wind and sun exposure. This is manifestly a difficult and expensive specification and the actual equipment will be only an approximation of the ideal.

Keeping in mind that the heating system is designed for the extreme weather conditions occurring less than 5% of the season it is obvious that during the rest of the heating season the flow of heat must be retarded, shut off, or in some way regulated if overheating and waste is to be prevented. Fairly good regulation may be accomplished by simply shutting off the steam at the entrance of the building for intervals during the day in accordance with a table based on outdoor temperature. It may be done by hand or automatically.

At this point it will be well to clear up a wrong idea that has resulted in dissatisfaction with steam heating and has led to much waste. The misconception is this: that if a pressure of several pounds on the heating system results in too much heat and zero pressure gives no heat, there must be some intermediate pressure that will give the correct amount. This is not true in the ordinary system because the pressure determines rather the distance that the steam will travel than the amount of steam which will be delivered to each of the radiators. One pound pressure may fill the last radiator with steam, while one-half pound may not deliver any steam to the last radiator, i.e., leave it cold, although the first radiators are fully heated. The temperature of steam, however, at one pound (215.3F) and at one-half pound (213.7F) differs by less than 1%.

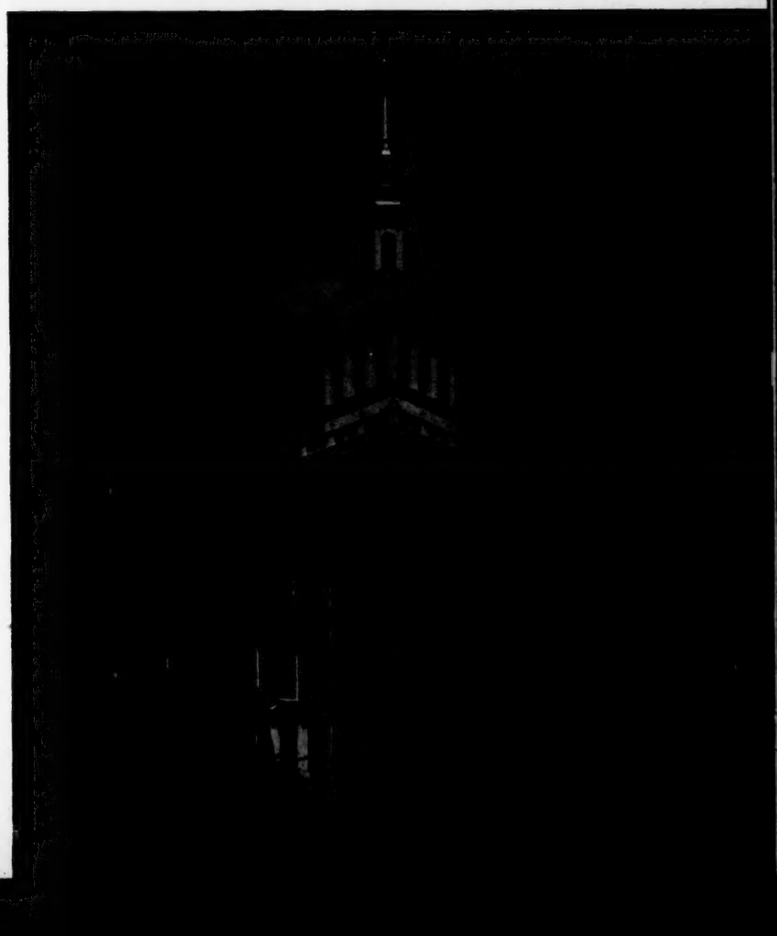
The throttling of the main supply valve, reducing the pressure, is therefore not in itself a satisfactory way to regulate the heating system, unless the radiators are fitted with properly designed orifice plates to proportion the steam flow into them. Otherwise, throttling, sufficient to reduce the pressure and flow, will fill the near radiators of the system, fully heating them, while the steam will not reach the distant ones and they will be cold.

Several well-known types of control may be listed:

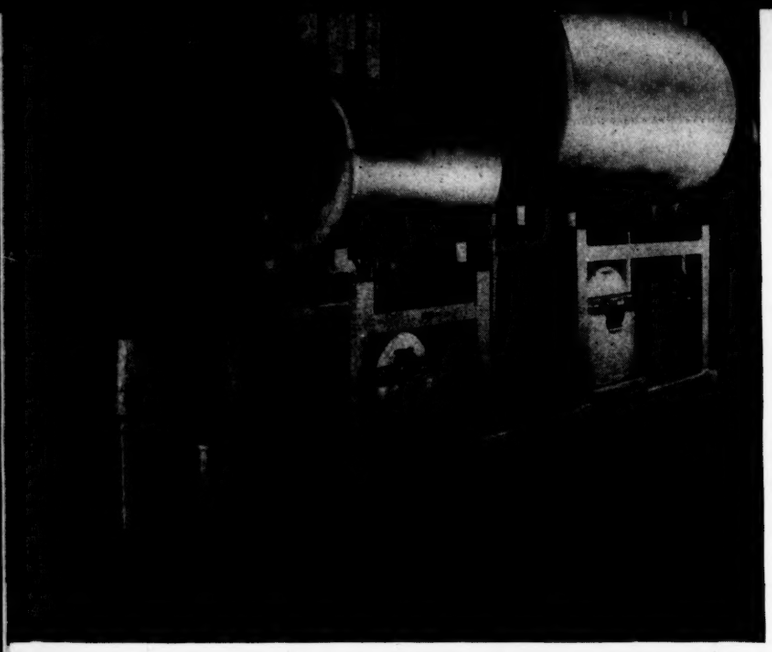
1. *Intermittent Heating*

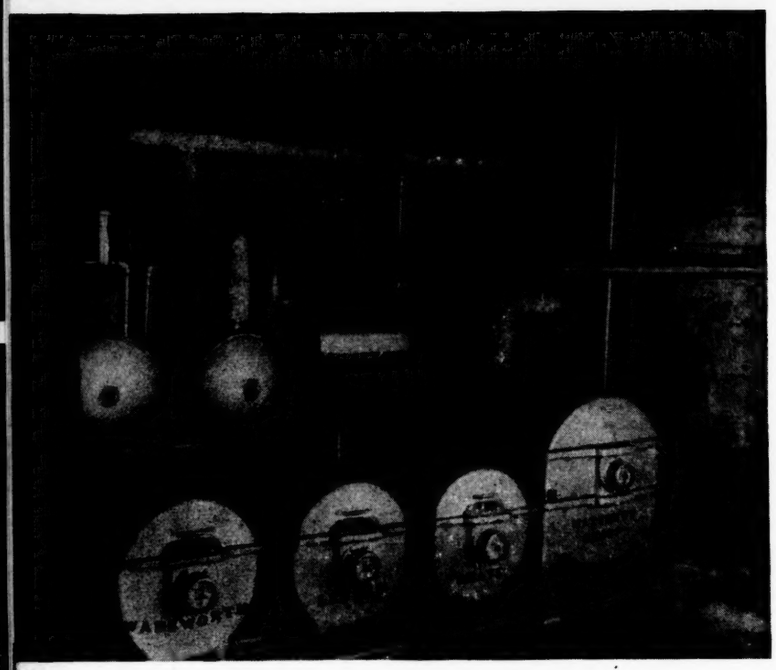
This method of control embodies a program disc rotated by a clock, which turns on the steam for say a half hour and then off for a half hour during the heating period. The on and off periods may be lengthened or shortened, and the starting up and shutting down varied to suit the weather conditions, the discs being tailor-made to suit the building.

A late form of intermittent control is fitted with an outdoor thermostatic bulb which automatically lengthens the steam admission periods and shortens off periods in cold weather and vice versa in mild weather.



An outstanding landmark on the Harvard campus—the Lowell House tower.





Above—A group of forced hot water meters located in the Eliot House. Below—Meters on a group of Yard buildings. A single pumping trap is located in a pit beneath the meters.

2. *Continuous Low Pressure Heating*

This method of control may be used only in two-pipe vapor or vacuum systems. The piping must be in good order to permit good circulation. Steam is applied continuously during the heating period of the day, at a pressure just sufficient to heat the last radiator. Individual tenants may then control the heat in their own radiators by partially opening their radiator valves, which is possible only with very low pressures, for when high pressures are used only a small opening of the radiator valve will admit enough steam to fill the radiator.

The use of a vacuum pump with restricted steam inlet pressure permits operation in the lower steam temperature range. For example, the temperature of steam at 10 in. vacuum is 193F; at 15 in. the temperature is 179F. Thus the radiator temperature may be varied widely with weather conditions.

3. *Fixed Orifices*

Although, as pointed out, the ordinary steam heating system cannot be controlled by throttling the steam supply, most of the two-pipe vapor or vacuum systems can be controlled in this way when the radiators are fitted with orifice plates—discs with small holes installed at the radiator inlet, which limit the steam flow into the radiator. These discs may be installed in the radiator valve union. The size of the hole must be carefully determined in accordance with the size of the radiator and its distance from the point of pressure or steam admission control. Rules for this procedure may be found in the literature.

Since it is impractical to design the supply piping of a steam heating system so that the resistance to steam flow to every radiator will be exactly proportional to the radiator sizes, the orifice plate is used to balance the resistances and thus properly to porportion the flow.

Since low pressure differentials are used, the system must be free from pockets or other faults restricting the free circulation of steam.

A gravity system fitted with orifices should have its returns well vented so that the pressure in them will not be above atmospheric.

Should a radiator be too large in a given space, the overheating can be corrected by installing the proper orifice in the inlet.

The control of the steam pressure and the pressure or vacuum on the returns is important if a vacuum system is used, and it must follow weather conditions if economy is to be achieved. In a proprietary orifice system, the equipment for controlling steam pressure and vacuum in the returns is supplied by the manufacturer as part of the system. In a homemade system a simple control may be applied to the reducing valve, or a hand operated valve readily accessible on the low side of the reducing valve may be used for regulation.

In addition to making possible the operation of the heating system at lower temperatures by the use of vacuum, orifices permit operation with partially filled radiators in mild weather, thus giving a wide range of radiator output.

4. *Pulsating Steam Supply*

Low pressures are sometimes difficult to control accurately. Furthermore, an existing piping system may not distribute steam well at low pressure. The short period pulsating steam supply will overcome these difficulties. It may be used with or without orifices, though the latter will undoubtedly improve the distribution in a large system. As an example, steam may be turned on for three minutes and off for four minutes, the intervals being short enough to prevent the radiators from cooling completely. The length of *steam-on* period is adjusted to the weather conditions.

5. *Vacuum Heating*

With a gravity system the pressure range for control is roughly from 5 to 0 lb. gauge, or a temperature range of from 228F to 212F; only 16°. The pressure in a vacuum heating system may be as low as 25 inches of mercury vacuum, giving a maximum temperature range of from 228F to 133F, about six times the range of temperature possible in a gravity system. By adding orifices to the radiators the inlet pressure may be low-

ered so that there will be only partial filling of the radiators, with the result that their average temperature will be still further lowered.

Carrying a vacuum on the radiators and piping causes air to enter wherever there are leaks. In mild weather when the system should be operated at very low pressure differences, there is a tendency for any air leakage to air-bind the portion of the system close to the air leak so that no steam is supplied to the radiators so affected. When this happens, the operation may need excessive differential to carry steam to the cold radiators. Vacuum systems must be tight if good results are to be attained.

Individual Room Thermostats

Another popular method of controlling building heating is by means of individual room thermostats controlling the steam to the radiators with radiator valves. This system permits variation of temperature from room to room to suit the desires of occupants. When it is remembered that the comfort zone varies from 65F to 75F there is something to be said in favor of this method, provided it is feasible to group the *warm-blooded* folks in the cool room and the *cold-blooded* ones in the warm room. The individual room thermostat method of control does render a higher quality of service.

In recent years a number of manufacturers have marketed self-contained thermostatic radiator valves for individual room control.

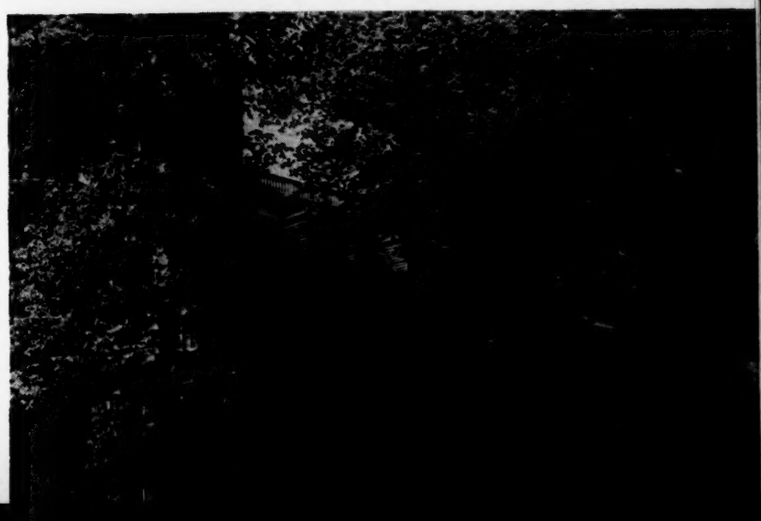
Home Made Control

Another simple control which has done a good job here at Harvard has been applied to the older steam heated buildings. It consists of (a) a thermostatic element which may be either a room thermostat if a suitable location for it can be found, or an aquastat attached to the remotest radiator, or a duostat with one element outdoors and the other on the last radiator; (b) a single seated pressure regulating valve fitted with a closing motor actuated by the aquastat, a limit stop, and a solenoid-operated closing trip toggle on the limit stop operated by (c) an outdoor mercury thermostat. The control radiator is often an extra radiator mounted in the basement where it is easily accessible, with the connection run down from the last radiator.

Briefly, the operation of this control is as follows: when steam is turned on in the morning, and the thermostat or aquastat is calling for heat, the pressure regulating valve admits steam at a pre-determined pressure sufficient to rapidly fill the entire system. When the building reaches the desired temperature and the thermostatic element is satisfied, or the control radiator is hot, the motor closes the valve to a limit stop which is adjusted to pass only sufficient steam to keep the piping warm. This reduced pressure as indicated on the manometer installed with the control will vary from a slight vacuum to a pressure of a few ounces, depending on the building and its piping system. After the building is heated up in the morning the effect of this control is to interrupt the steam supply for longer or shorter periods until the steam is shut off at night. Should the outdoor temperature rise to 58F or 60F the outdoor thermostat will trip the limit stop on the reducing valve and allow it to close completely. Thus the steam supply is regulated roughly in accordance with weather conditions; as the temperature moderates, the pressure and consequently the steam flow are greatly reduced, and when the outdoor temperature rises still further the steam supply is completely stopped. This inexpensive arrangement has worked well, and paid for itself usually in a single heating season.

Hot Water Heating

A hot water heating system with heat exchanger supplied from the steam mains lends itself nicely to control, which while very simple still produces good economy. With pressure maintained on the heating water by an air tank in the apparatus room, the water temperature may be carried just as high as the temperature in steam heating systems and of course the temperature may be lowered to any point desired, giving a



Two well-known buildings of Harvard University. The upper illustration is of the Harvard biological laboratories, which were built in 1931. The lower photograph shows Massachusetts Hall which, during last summer, had its first and second floors reconstructed to house fully air conditioned executive offices.

very wide radiator temperature range. Control may be accomplished by a double thermostatic unit, one bulb located on the outside of the building and the other in the return water main. The joint effect of these thermostatic elements varies the water temperature to suit conditions. This control with properly timed steam *on* and *off* morning and night, week-ends and holidays, produces good economy.

The simplicity of the control and other features of this type of system make it well suited to college buildings and led to its use in most of the new buildings at Harvard.

The hot water system operates silently; there is no hissing, no pounding. The piping is not subject to internal corrosion, so that if it is protected against external corrosion it is practically permanent, may be built into the structure and need never be disturbed. The steam using equipment is confined to the apparatus room where it can be made readily accessible for repairs and replacement. The radiators at temperatures ordinarily carried will not burn the skin.

In the larger buildings forced water circulation is used, while in the smaller ones the heating water circulates by gravity. The new Law building of three stories and basement with 600 ft. frontage has a gravity hot water system which performs well.

Substantial Savings Made

These controls, along with careful attention by the operators to schedules for turning steam on and off morning, night, and week-ends, have resulted in substantial economies in heating the Harvard buildings, as shown in the following comparison of heating costs in 1930-31, the year following the closing of a contract for steam with the local utility, and 1932-33, two years later, which was a winter of about the same severity. The heavy construction program in progress through this period, involving varying building volume on the lines and a considerable use of steam in construction, makes a comparison of total heating costs for the two years meaningless. Therefore a representative list of buildings is taken for comparison. The figures are the total net charges, including expense for the operation and care of ventilating and other machinery in the building. Labor charges, and steam rates are the same for the two years.

It should be noted that the heating equipment in a number of new buildings just added to the system had not been fully adjusted to the best operation.

The list, which includes some large and some small buildings, some new and some old ones, shows what can be done with simple and inexpensive control equipment and a careful scheduling of steam supply to suit the building needs.

In total, the economies effected at that time were of the order of $50,000 a year. If the comparison were extended back to earlier years the figures would be more striking still. Widener Library, for example, was charged about $16,000 for heating expense.

Since the tabulation was made there have been further gains, though the irreducible minimum has almost been reached. The last increments of gain are of course the most difficult to achieve. The job now consists chiefly in holding the gains made. This requires constant watchfulness over the records and close attention to the operating details. An economical heating job is not assured by the mere installation of an automatic control. A thorough knowledge of the building is necessary—the construction of the building, the building equipment, and the use of the building must be studied to determine heat losses, hours of heating, required temperatures for the occupancy and similiar items.

Meters are necessary if heating is to be done economically. Each building should be equipped. Daily readings should be taken and compared with the degree day figures (furnished by the local Weather Bureau office), and with other buildings of the same size and similar occupancy. In this way the wasteful use of steam will become apparent. Reasons may then be ascribed for excessive use, or if investigation indicates trouble in the equipment, steps may be taken to remedy it. Without meters and an accurate record of steam use economical operation cannot be achieved. The condensate type of meter is relatively low in cost, more accurate for our purposes than other types, and is easy to maintain and calibrate. We have found that the expense of meters and of keeping records is trivial compared to the savings that may be made.

TABLE 1—SAVINGS MADE IN HARVARD BUILDINGS BY GOOD OPERATION, SUPERVISION AND CLOSE CONTROL

Building	Saving, Dollars		Percent Saving
	1930-31	1932-33	
Randolph Hall (dormitory)	4,575.10	2,571.50	44
Boylston Hall (class rooms)	1,808.64	1,424.94	21
Baker Library	10,767.15	8,972.55	17
Morgan Hall (offices)	2,894.29	2,606.37	10
Claverly Hall (dormitory)	3,499.00	2,434.55	30
Dunster House (dormitory)	8,240.38	6,374.66	23
Dudley Hall (dormitory)	2,196.00	1,783.34	19
Emerson Hall (class rooms)	3,492.00	2,460.54	30
Fogg Museum	5,213.70	4,489.96	14
Harvard Hall (class rooms)	1,920.10	1,199.09	37
Indoor Athletic Building	10,023.70	8,382.86	16
Langdell Hall (law library)	13,067.72	9,929.81	24
Lehman Hall (business administration)	2,379.31	1,581.13	33
McKinlock (dormitory)	4,491.57	3,585.61	20
Lowell House (dormitory)	9,980.28	8,566.66	14
Mallinckrodt and Converse (chem. lab.)	10,514.78	7,260.09	31
Music Building	1,401.24	666.70	52
Peabody Museum	2,100.00	1,058.25	50
Pierce Hall (engineering laboratory)	2,672.52	2,132.29	20
Randall Hall (print shop)	1,341.33	1,110.32	17
Robinson Hall (architecture)	3,411.10	1,546.20	55
Sever Hall (class rooms)	4,662.00	3,061.95	34
Soldiers Field (athletic buildings)	11,994.00	8,998.51	25
Straus Hall (dormitory)	1,429.45	1,165.75	18
Thayer Hall (dormitory)	2,706.54	2,108.30	22
University Hall (academic administration)	1,804.80	1,498.14	17
University Museum	4,482.56	3,426.04	24
Wadsworth House (alumni office)	999.73	419.65	58
Widener Library	11,839.84	8,031.02	32
Harvard Union (freshman club)	10,285.76	8,087.17	21

Estimating Heat Flow Through Sunlit Walls

PART 2—COMPOSITE WALLS

By C. O. MACKEY† and L. T. WRIGHT, JR.‡

The problem of finding a rational methed of determining the cooling load as affected by solar radiation on building surfaces is a very important one. Tables have been available for some time giving the instantaneous cooling load due to the transmission of solar radiation by window glass. Heretofore there has been no published method whereby the effect upon the cooling load of sunlit walls and roofs could be obtained. The authors of this article have developed such a method. It is being published in three parts in HEATING & VENTILATING.

Last month in Part 1 of this series the authors developed a method applicable to walls built of one material. In the present installment they present a method which may be used with walls of more than one material. In the succeeding installment they will show how the method may be applied to typical constructions.

THE methods presented in last month's article were applicable only to those walls which may be considered as homogeneous or simple walls, such as solid concrete, brick, or stone. Many of the walls encountered in air conditioning calculations, however, are composite walls. The approximate method outlined last month may be applied to composite walls using the same equations as before for the surface temperatures and the same equation for the temperatures of the thin slabs. It is only necessary to add one more equation to determine the temperature of the junction of two different materials. At such a junction, the temperature of the last slab of one material must be the same as the temperature of the first slab of the second material. Also, the same amount of heat must flow into the second material as flowed out of the first material.

Let t_e = the temperature of the junction,
t_{e-1} = the temperature of the slab just before the junction,
t_{e+1} = the temperature of the slab just after the junction,
k_{e-1} = the conductivity of the slab just before the junction,
k_{e+1} = the conductivity of the slab just after the junction

Then

$$\frac{k_{e-1}}{\Delta x_{e-1}}(t_{e-1}-t_e)=\frac{k_{e+1}}{\Delta x_{e+1}}(t_e-t_{e+1})$$

$$t_e=\frac{\dfrac{k_{e-1}}{\Delta x_{e-1}}t_{e-1}+\dfrac{k_{e+1}}{\Delta x_{e+1}}t_{e+1}}{\dfrac{k_{e-1}}{\Delta x_{e-1}}+\dfrac{k_{e+1}}{\Delta x_{e+1}}} \qquad \text{.....(12)}$$

It was previously assumed that $\dfrac{a_j\Delta\theta_j}{(\Delta x_j)^2}=\frac{1}{2}$ (where the subscript j refers to the different materials) in order to simplify the calculations. It should be noticed that in a composite wall this limits the choice of the number of slabs into which the wall may be divided, for, assuming a wall of two materials, it is necessary to take equal time increments.

Then

$$\Delta\theta_1=\Delta\theta_2$$

$$\frac{(\Delta x_1)^2}{2a_1}=\frac{(\Delta x_2)^2}{2a_2}$$

$$\frac{\Delta x_1}{\Delta x_2}=\frac{\sqrt{a_1}}{\sqrt{a_2}}$$

or in terms of the number of slabs in each material

$$\frac{n_1}{n_2}=\frac{L_1\sqrt{a_2}}{L_2\sqrt{a_1}} \qquad \text{.....(13)}$$

where n_1 and n_2 must be integers. Therefore, this method is rather difficult to use if the materials have different thermal diffusivities.

The easiest way to treat these composite walls is to determine their simple wall equivalent. The equivalent wall may be defined as a simple wall such that it has the same surface absorptivity and gives the same rate of heat transfer to the conditioned space at each hour of the day as the composite wall. The only variables available in the simple wall are the thickness L, the thermal diffusivity a, and the thermal conductivity k. These may be found from the properties and conditions imposed on the composite wall. For example, it is easy to determine the ratio $\left(\frac{k}{L}\right)$ for the equivalent wall by considering steady flow of heat through each of the walls. For equivalent effects, the overall transfer coefficients must be equal. That is

$$U_{simple}=U_{composite}$$

$$\frac{1}{\frac{1}{h_1}+\frac{1}{h_2}+\frac{L}{k}}=\frac{1}{\frac{1}{h_1}+\frac{1}{h_2}+\frac{L_1}{k_1}+\frac{L_2}{k_2}+\cdots\cdots+\frac{L_n}{k_n}}$$

$$\frac{k}{L}=\frac{1}{\frac{L_1}{k_1}+\frac{L_2}{k_2}+\cdots\cdots+\frac{L_n}{k_n}} \qquad \text{.....(14)}$$

An equivalent value of $\frac{L^2}{a}$ for the composite wall may be found from the following empirical equation, based upon a study of results calculated by the use of the approximate method:

†Professor of Heat-Power Engineering, Cornell University.
‡Graduate Student in Mechanical Engineering, Cornell University.

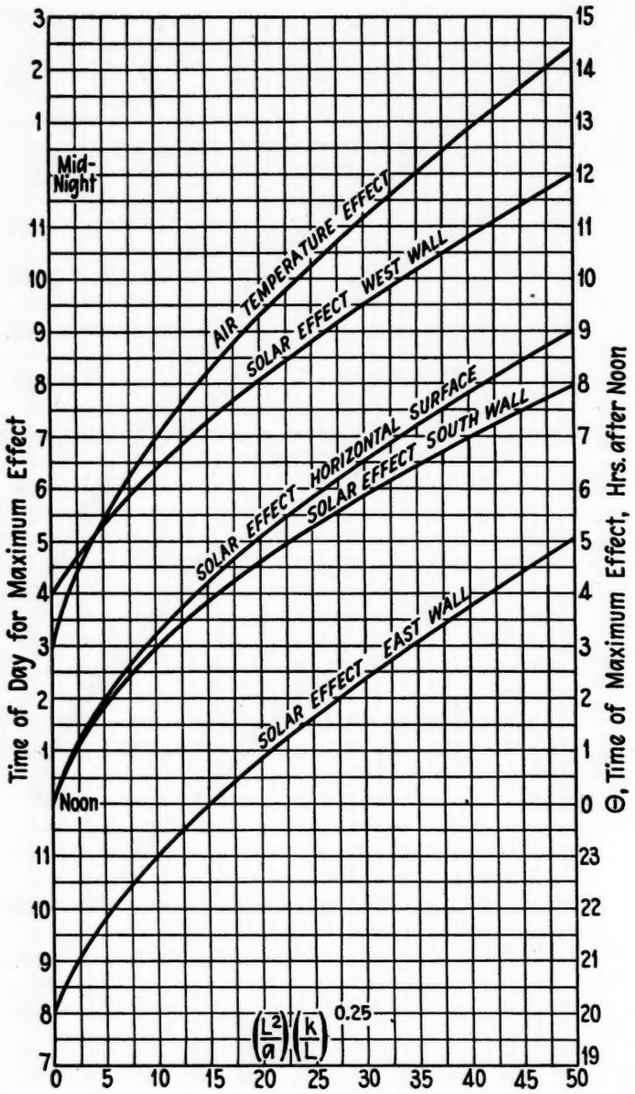


Fig. 2. Times of maximum effect for the separate components of the cooling load. Vertical scale is θ_m time of maximum effect, hours after noon.

$$\left(\frac{L^3}{a}\right)\left(\frac{k}{L}\right)^{1/4} = \left\{\left|\left(\frac{L_1^3}{a_1}\right)\left(\frac{k_1}{L_1}\right)^{1/4}\right|^{2/3} + \left[\left(\frac{L_2^3}{a_2}\right)\left(\frac{k_2}{L_2}\right)^{1/4}\right]^{2/3} + \cdots\cdots + \left(\frac{L_n^3}{a_n}\right)\left(\frac{k_n}{L_n}\right)^{1/4}\right|^{2/3}\Bigg\}^{3/2} \quad \cdots\cdots (15)$$

As an example of the method of finding an equivalent wall, consider a composite wall composed of 4″ of brick $\left(\frac{L_1^2}{a_1} = 7.41, \frac{k_1}{L_1} = 1.25\right)$, 3″ of rock wool $\left(\frac{L_2^2}{a_2} = 4.17, \frac{k_2}{L_2} = 0.10\right)$, and ¾″ plaster on metal lath $\left(\frac{L_3^2}{a_3} = 0.098, \frac{k_3}{L_3} = 0.73\right)$.

$$\left(\frac{L^3}{a}\right)\left(\frac{k}{L}\right)^{1/4} = \Big\{[(7.41)\ (1.25)^{1/4}]^{2/3} + [(4.17)\ (0.10)^{1/4}]^{2/3} + [(0.098)\ (0.73)^{1/4}]^{2/3}\Big\}^{3/2}$$

$$= 14.4$$

$$\frac{k}{L} = \frac{1}{\frac{1}{1.25} + \frac{1}{0.10} + \frac{1}{0.73}}$$

$$= 0.0821 \text{ B.t.u. per hr. sq. ft. deg. F.}$$

$$\frac{L^3}{a} = \frac{14.4}{(.0821)^{1/4}}$$

$$= 26.9 \text{ hrs.}$$

Hourly Variation in Cooling Load

The most convenient way of determining the hourly variation in the rate of heat transfer to the indoor air due to solar and air temperature effects is to break down the cooling load into these two components. In Fig. 2, the times of maximum effect of air temperatures, alone, upon the cooling load, and the times of

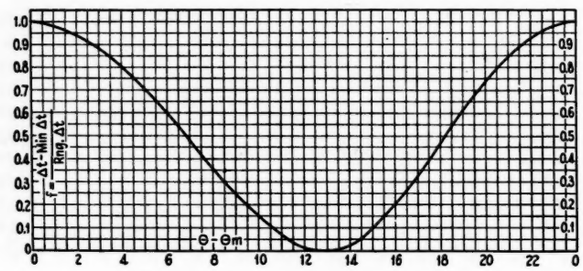


Fig. 3. Air temperature effect.

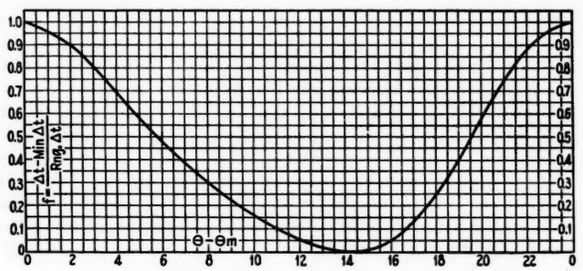


Fig. 4. Solar effect—horizontal surface.

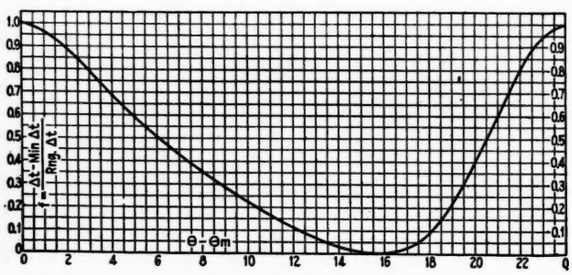


Fig. 5. Solar effect—south wall.

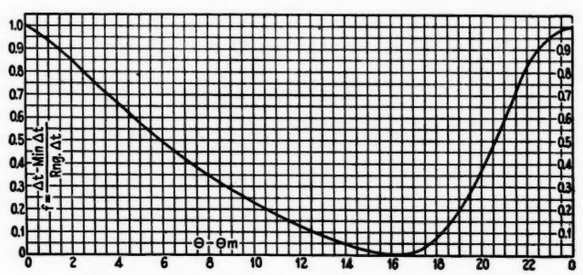


Fig. 6. Solar effect—east and west walls.

maximum sun effect are shown plotted against $\left(\frac{L^2}{a}\right)\left(\frac{k}{L}\right)^{0.25}$. For example, for an East wall with $\left(\frac{L^2}{a}\right)\left(\frac{k}{L}\right)^{0.25} = 20$, the time of maximum air temperature effect is 9.3 hours after noon, while the time of maximum solar effect, alone, is 0.85 hours after noon. Since some companies manufacturing air conditioning apparatus have prepared empirical tables of total temperature differentials to be used in estimating the cooling load, the daily variations are correlated on the basis of total temperature differentials.

If the maximum rate of heat transfer to the indoor air due to each effect be divided by the overall coefficient of heat transfer of the wall, a maximum temperature differential is obtained. By dividing the first two terms in Eq. (11) by U, the air temperature effect, measured as a temperature difference Δt, is obtained. This effect is independent of the value assumed for the individual thermal resistance of the outside air film. By dividing the last two terms of Eq. (11) by U, the solar effect, measured as a temperature difference, is obtained. These terms contain, in the denominator, an assumed value of h_o (B.t.u. per hr. sq. ft. deg. F) for the film coefficient of heat transfer at the outside surface of the wall.

Alford, Ryan, and Urban combine the effects of convection and of radiation to surrounding solid surfaces (assumed to be at a temperature equal to that of the air) into a single coefficient shown to equal 4.3 B.t.u. per hr. sq. ft. deg. F at a wind velocity of 8.1 m.p.h., the average summer value for 69 cities. In the preparation of the figures and tables that follow, the authors have used a value of 4 for this coefficient, which value is on the safe side of the average. This maximum Δt is plotted, in Fig. 7, against the time of day for maximum effect, as read from Fig. 2. For the East wall described above, maximum Δt for air temperature effect, alone, is read at 9.3 hours after noon as 11.3F, while max Δt for solar effect, alone, is read at 0.85 hours after noon as 23.3F. Next, in the preparation of these curves, the minimum rate of heat transfer to the indoor air due to each effect was divided by the overall coefficient of heat transfer to obtain a minimum temperature differential; by subtraction of this minimum temperature differential from max Δt, the range in Δt, or rng Δt was found and plotted against the time of day of maximum effect in Fig. 8. Thus, for the East wall of the example, rng Δt for the air temperature effect is read as 7.7F at 9.3 hours after noon, while rng Δt for the solar effect, alone, is read as 22.4F at 0.85 hours after noon. The minimum temperature differentials may be found by subtracting rng Δt from max Δt; for this wall, min Δt for the air temperature effect is (11.3 — 7.7) or 3.6F, and for the solar effect (23.3 — 22.4) or 0.9F. Next, the difference between the actual temperature differential, at any time, and the minimum temperature differential, expressed as a fraction of the range in Δt, is plotted against the difference between that time, measured after noon, and the time of maximum effect, as read from Fig. 2. The effect of air temperature is shown in Fig. 3, and the solar effect for a horizontal surface in Fig. 4, for South walls in Fig. 5, and for East and West walls in Fig. 6. From the charts, the temperature differential at any hour of the day may be found. For this East wall at

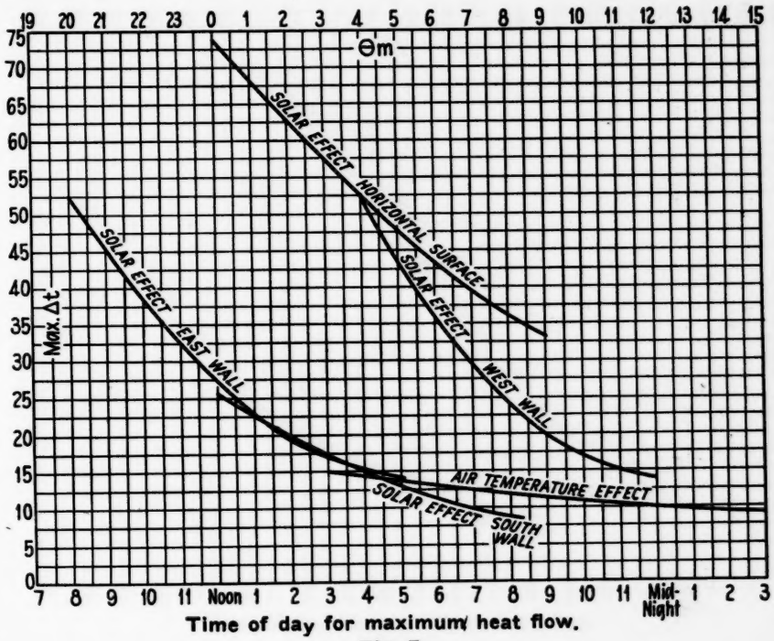


Fig. 7

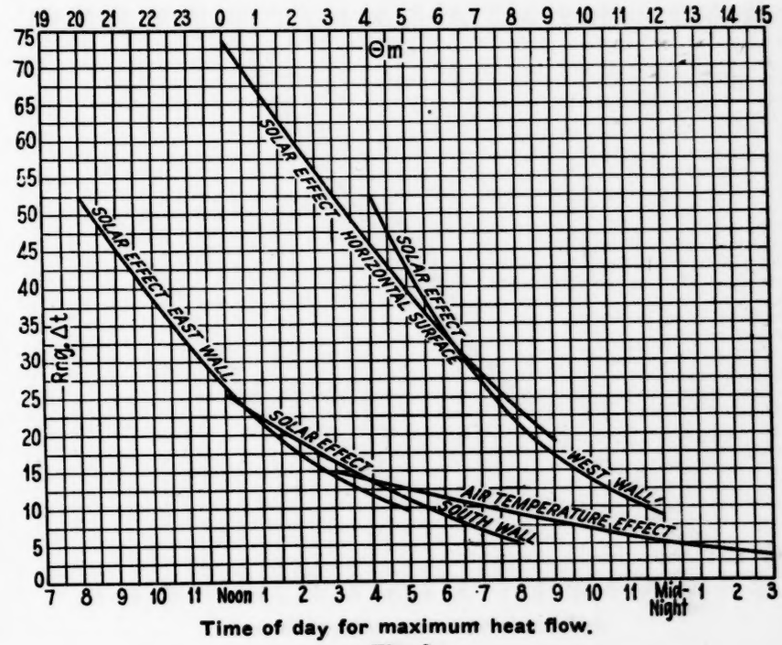


Fig. 8

TABLE 5.—CALCULATIONS TO DETERMINE THE TOTAL TEMPERATURE DIFFERENTIALS FOR COMBINED AIR TEMPERATURE AND SOLAR EFFECT FOR AN EAST WALL†

AT TIME OF MAXIMUM EFFECT

TIME OF MAX. EFFECT, θ_m, HRS. AFTER NOON (FROM FIG. 2)		MAX. TEMP. DIFF., MAX Δt (FROM FIG. 7)		RANGE OF TEMP. DIFF., RNG Δt (FROM FIG. 8)		MIN. TEMP. DIFF., MIN Δt (MAX Δt — RNG Δt)	
AIR TEMP. EFFECT	SOLAR EFFECT	AIR TEMP. EFFECT	SOLAR EFFECT	AIR TEMP. EFFECT	SOLAR EFFECT	AIR TEMP. EFFECT	SOLAR EFFECT
9.3	0.85	11.3F	23.3F	7.7F	22.4F	3.6F	0.9F

AT VARIOUS HOURS OF THE DAY

TIME OF DAY	θ, HOURS AFTER NOON	$\theta - \theta_m$*		$f = \frac{\Delta t - \text{Min}\Delta t}{\text{Rng}\Delta t}$		$(\text{Min}\Delta t) + f\,(\text{Rng}\Delta t)$		Δt COMB. EFFECTS
		AIR TEMP. EFFECT	SOLAR EFFECT	AIR TEMP. EFFECT (FIG. 3)	SOLAR EFFECT (FIG. 6)	AIR TEMP. EFFECT	SOLAR EFFECT	
8 A.M.	20	10.7	19.15	0.09	0.22	4.3	5.8	7.2
10 A.M.	22	12.7	21.15	0.00	0.63	3.6	15.0	11.1
12 Noon	0	14.7	23.15	0.07	0.965	4.1	22.5	15.4
2 P.M.	2	16.7	1.15	0.29	0.925	5.8	21.6	16.6
4 P.M.	4	18.7	3.15	0.57	0.74	8.0	17.5	16.8
6 P.M.	6	20.7	5.15	0.81	0.56	9.8	13.4	16.5
8 P.M.	8	22.7	7.15	0.97	0.41	11.1	10.1	16.2
10 P.M.	10	0.7	9.15	0.99	0.28	11.2	7.2	14.8
12 Midnight	12	2.7	11.15	0.90	0.17	10.5	4.7	12.9

†$\left(\frac{L^2}{a}\right)\left(\frac{k}{L}\right)^{0.25} = 20$; b (the absorptivity of the surface) = 0.5 *When $\theta - \theta_m$ is negative, add 24 hrs.

8 A.M., for the air temperature effect, $\theta - \theta_m = 20 - 9.3 = 10.7$, and ($\Delta t$ — min Δt) is, from Fig. 5, 0.092 of rng Δt; at this time, then, $\Delta t = 3.6 + 0.092\ (7.7) = 4.3F$. For the solar effect upon this East wall at 8 A.M., $\theta - \theta_m = 20 - 0.85 = 19.15$, and ($\Delta t$ — min Δt) is, from Fig. 6, 0.22 of rng Δt; at this time, for the solar effect, $\Delta t = 0.9 + 0.22\ (22.4) = 5.8F$. The total temperature differential for the combined air temperature and solar effect is found by adding to the differential for the air temperature effect, alone, the product of the temperature differential for the solar effect and the absorptivity of the wall surface. Thus, if the East wall of the example has an absorptivity for incident solar energy of 0.5, the actual equivalent total temperature differential at 8 A.M. is 4.3 + 0.5 (5.8) or 7.2F. The actual rate of heat transfer to the indoor air at this time, expressed in B.t.u. per hr. sq. ft. of wall surface, may be found by multiplying the overall coefficient of heat transfer for this wall by this temperature difference (the overall coefficient of heat transfer should be based on a value of 4 for the outside film coefficient).

In Table 5 are shown the total temperature differentials together with the method of obtaining them, for this wall at other hours of the day.

The following is a summary of the method to be followed in obtaining the rate of heat transfer to the indoor air due to air temperature effect and solar effect at any hour of the day:

1. From the thickness, L, in ft., the thermal conductivity, k, in B.t.u. ft. per hr. sq. ft. deg. F., and the thermal diffusivity, a, sq. ft. per hr. (Table 4) of a wall of one material, calculate $\left(\frac{L^2}{a}\right)\left(\frac{k}{L}\right)^{0.25}$; for a wall of several materials, use Eq. (15).
2. From Fig. 2, read the times of maximum air temperature effect and maximum solar effect, θ_m.
3. From Fig. 7, at these two values of θ_m, read two values of Max Δt, one for the air temperature effect and the other for the solar effect.
4. From Fig. 8, at these two values of θ_m, read two values of Rng Δt, one for the air temperature effect and the other for the solar effect.
5. By subtracting Rng Δt from Max Δt, find two values of Min Δt, one for air temperature effect and one for solar effect.
6. Calculate the values of $(\theta - \theta_m)$ at each hour of the day when the cooling load is to be found (for the air temperature effect); with these abscissae, read the ordinates, f, on Fig. 3.
7. Calculate the values of $(\theta - \theta_m)$ at each hour of the day (solar effect); from appropriate figure (4, 5, or 6), read the ordinates, f.
8. Find the air temperature difference for the air temperature effect by adding Min Δt to f (Rng Δt); same for the solar effect.
9. To Δt for the air temperature effect, add the product of the absorptivity of the outside wall surface and Δt for the solar effect; multiply this sum by the overall coefficient of heat transfer of the wall to obtain the rate of heat transfer to the indoor air, in B.t.u. per hr. sq. ft.

For any shaded surface, only the air temperature effect is used.

Air conditioned continuous spinning room, Industrial Rayon Corp., Painesville plant.

A SECTION OF
INDUSTRIAL PLANTS
BY

INDUSTRIAL RAYON CORPORATION

operates over 1800 tons of refrigeration in its air conditioned Painesville plant. Brine, cooled in central power house, circulates through coils in capillary type conditioner, features of which include cleaning ability and low pump capacity needed.

THE eleven-and-a-half-million-dollar plant of Industrial Rayon Corporation at Painesville, Ohio, for the production of a new type rayon yarn by a continuous spinning process, was placed in operation well over a year ago, complete at that time except for additional continuous spinning machines. All of these machines are now installed and the plant has been operating with complete equipment for several months. Reports indicate that this ultra-modern, windowless, air conditioned plant has proved most satisfactory.

Fourteen acres of floor space have been provided in the buildings which occupy part of a 508-acre site extending along the southern shore of Lake Erie for almost two miles.

General

New-type continuous machines have been installed in a three-and-a-half-acre spinning room, certainly among the largest single-purpose operating rooms in American industry. Scores of machines, arranged in tandem and standing 20 feet high on the working floor, make this the heart of the new plant. Walkways have been built at two different levels for operators who supervise the consecutive operations as yarn is formed in the spin bath on the upper level and moves over a series of reels down through the process section, to bobbins which are set low on the machines near the floor.

Cellulose fiber sheets are dissolved in a series of controlled chemical baths in the initial processing and take form as rayon fiber at the top of these machines, where glass-enclosed spin tanks are located. This liquid rayon is forced through the minute holes of a submerged nozzle to produce the numerous delicate filaments of rayon fiber which make up each individual thread, as in all rayon manufacture, but from this point on the difference is marked.

Instead of being wound directly on a bobbin and treated in that form and handled repeatedly, the yarn is bleached, treated, dried and twisted before it is ever wound into a package. Moving continuously forward through processing liquids, cleansing baths and over drying reels as a single thread until it has been completely prepared for the textile mill, the rayon thus produced will conform to specifications for uniformity of fineness and physical characteristics which could not be guaranteed under the orthodox method.

The materials handling and routing has been designed to take maximum advantage of gravity flow throughout all stages of the operations. Incoming materials are received over an elevated trestle. Fluid chemicals are piped directly from tank cars to large

storage vats on the several floors of the four-story chemical building, while other dry materials are conveyed to bins and other storage facilities conveniently reached from this receiving dock. Materials in process work down from floor to floor to viscose aging tanks in the basement, and are forced up to the continuous spinners on the first floor by use of compressed air.

All ingredients used in the process are accurately measured at every stage along the line, and every solution is subject to chemical analysis in the large control laboratory which has been very completely equipped.

Power Plant

Three boilers, generating a total of 270,000 lb. of steam per hr. have been provided to operate three 5000 kw. bleeder condensing turbines. The power house and plant building are connected by a tunnel carrying pipes and conduit for steam, power, air, brine and water distribution. Bled steam at 15 lb. pressure is used for process work and for heating.

Also located in the power house are 8 vertical ammonia compressors driven by 8 synchronous motors with a total capacity of 1600 hp. The compressors in the power plant have over 1800 tons capacity, and are used to cool brine, which is then circulated by pumps to the air conditioning units and process equipment in the factory buildings and offices. The circulating brine system is extensive; the brine contains approximately

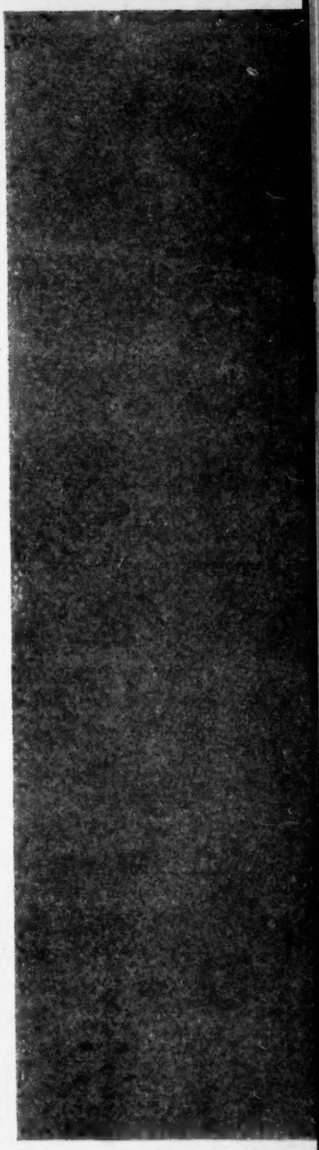
THIS INSTALLATION

Owner — Industrial Rayon Corporation

Location — Painesville, Ohio

Air Conditioning Design—Air & Refrigeration Corp. in Cooperation with L. J. Jordan, Chief Engineer, Industrial Rayon Corp.

Installed by—Air & Refrigeration Corp., New York, N. Y.



An air view of the 11½ million-dollar air conditioning plant of the Industrial Rayon Corporation which covers 14 acres at Painesville, Ohio. The plant has a capacity of 12,000,000 lb. of rayon yarn a year.

NUMBER 13

< < PROFITS

The upper part of the continuous spinning machines. It is in the part shown here that spinning takes place. A number of the air conditioning outlets can be seen in this view.

15 tons of calcium chloride in solution. Pumps with a total capacity of 5200 gal. per min. circulate the brine.

Air Conditioning

There are thirteen air conditioning systems provided for the plant and not including the entirely separate system serving the company's office building. These thirteen industrial systems serve areas as indicated in Table 1. System 8 is really four systems; they serve the continuous spinning room; each system has a capacity of 300 tons of refrigeration and each an air handling capacity of 150,000 c.f.m.

The four systems supplying the continuous spinning room are different from those for the remainder of the plant. The general arrangement of one of these systems is shown schematically in Fig. 2. In this system no air is recirculated. In the winter air is preheated by two groups of coils, one cutting in when the outside temperature falls to 35F and a second group cutting in when the outside temperature falls to 18F. The thermostat in the outside air inlet cuts these coils in by opening a motorized steam valve as indicated in Fig. 2. Air then passes through the water spray of heated water, the heating being done by steam entering into the reservoir through a steam injector. The amount of steam allowed to flow, and consequently the temperature of the spray water, is controlled from a dewpoint stat located in the chamber before the eliminator.

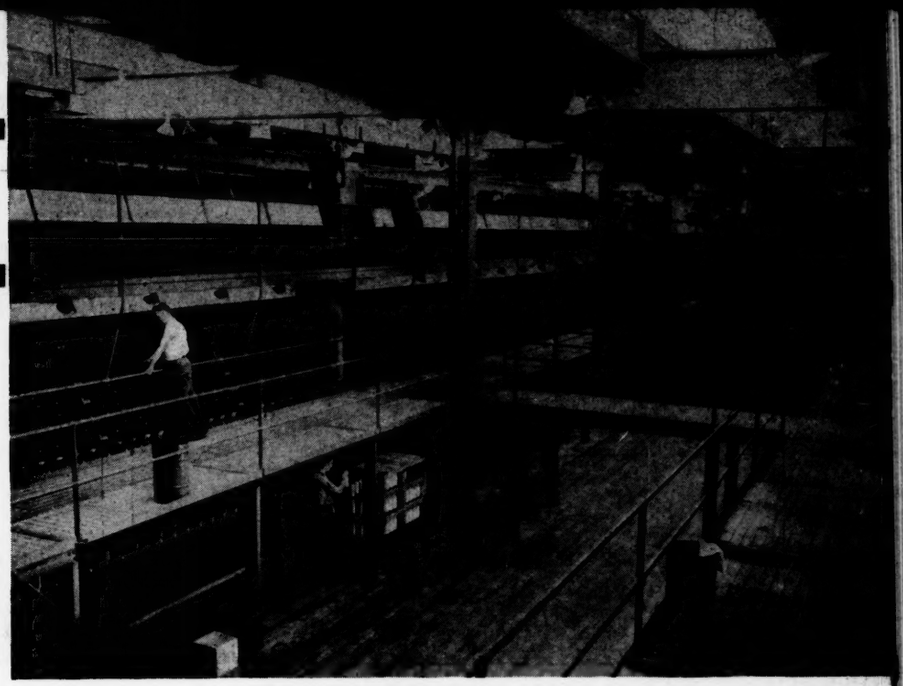
After passing through the eliminator the air is passed over a reheating coil, steam to which is controlled by a motorized valve operated from a room thermostat. The reheater brings the air up to the desired dry bulb and down to the desired relative humidity, after which the air passes through the fan inlet vanes into the fan, and thence to the continuous spinning room.

In the summer 40F calcium chloride brine is circulated from the refrigerating plant in the power house to the aluminum cooling coils. The flow of this brine to the coil is controlled from the dewpoint stat which also regulates the temperature of the water in the water spray. After passing over the precooler, the air is brought to the desired dewpoint in the capillary cells, passes through the eliminator, and is then reheated to the desired dry bulb under the control of the room

TABLE 1—DATA ON AIR CONDITIONING IN THE PLANT

System No.	Space Served	Air Conditions		Air Volume C.F.M.	Refrig. Cap., Tons	Lb. Steam Per Hr.
		Temp., F	R.H., %			
1	Coning Room	72	55 - 60	140,000	250	5,200
2	Warehouse	72	55 - 60	65,000	110	2,450
3	Viscose Cellar	65	C	32,000	97	1,675
4	Dissolver Room	69 - 72	C	5,000	17	315
5	Churn Room and Pulp Storage Room	69 - 72 / 70	C / 53	9,000	54	735
6	Aging Room	78	C	7,000	24	560
7	Filter Press and Shredder Room	69 - 72	55 - 60	12,000	41	750
8	Continuous Spinning Room	75	60	600,000	1,200	78,200
9	Spinning Room Exhaust, Fans Only	—	—	*	—	—
10	Laboratory	C	C	10,800	30	750
	Total			880,800	1,823	90,635

NOTE: C indicates "for comfort, as desired"
*Capacity 500,000 c.f.m.



Part of the 3½-acre continuous spinning room showing the machines which spin, process, dry and twist yarn in a single completed sequence. The air conditioning ducts can be seen in the upper part of the photograph.

thermostat which determines the amount of steam passing to the reheater. Make-up water is provided to the water spray as needed, although this is not shown in the diagram. The pump which circulates the spray water is powered by a 5-hp. motor on each of the four systems serving the continuous spinning room.

Features

There are three outstanding features of this air conditioning arrangement: (1) by using brine through cooling coils directly in the path of the air a maximum temperature difference between the air and the cooling medium is obtained, which gives greater efficiency of heat transfer and eliminates the usual step of cooling water with brine and using the water in direct contact with the air for reducing the heat content of the air stream. This not only saves extra equipment and maintenance, but reduces the overall pumping power required for circulating the combination of water and brine. By having a larger temperature differential between the air and the cooling medium, the brine piping system and, consequently, the volume of brine pumped is greatly reduced, with a marked saving in initial cost and a continued saving in reduced pumping power; (2) the capillary conditioners, consisting in the main of cells filled with glass strands over which water is sprayed, have greater efficiency as an air washer than the conventional spray chamber, because the surface for contact between air and water, producing heat and moisture exchange between the two liquids, is constant and does not require fine break-up of the water with consequent large water volumes and high pumping head (in fact, the total power for circulating water through the thirteen air conditioning systems which handle over 800,000 c.f.m., is only 23.2 brake horsepower); (3) capillary cells perform a dual function in the air stream, where they simultaneously condition and clean or filter the air passing through them. This operation is continuous, as the water passing through

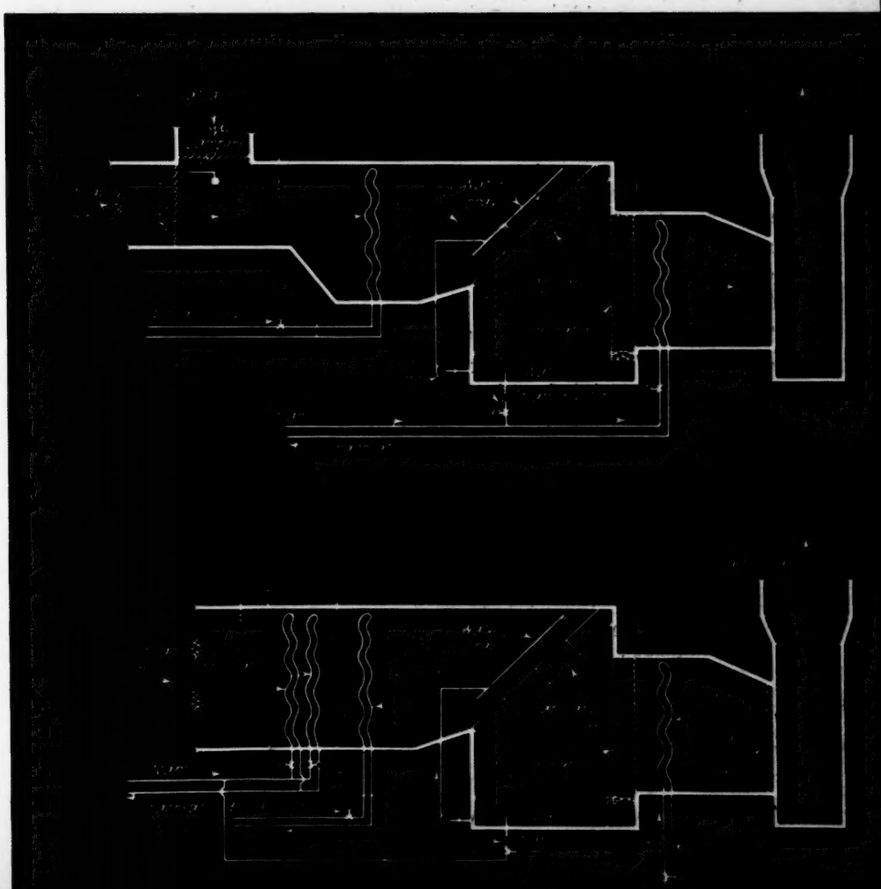
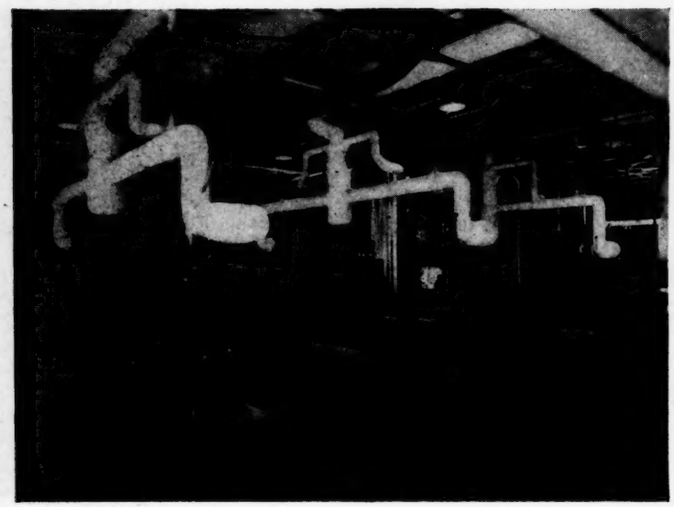


Fig. 1. (Above, right) Schematic diagram, not to scale, showing arrangement of conditioning apparatus as used in the plant other than the spinning room.

Fig. 2. (Below, right) Schematic diagram, not to scale, showing arrangement of conditioning apparatus serving the continuous spinning room.



The ammonia compressors which supply refrigeration for the Industrial Rayon plant.

These three 3200 hp. boilers burn pulverized coal. The pulverizing is carried on on the floor below.

the cells falls to the collecting tanks, where the solid matter is collected in a strainer and discharged to the sewer.

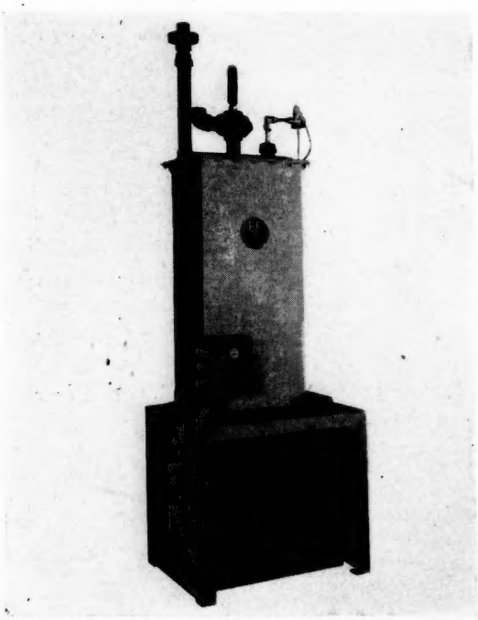
The arrangement of the conditioning apparatus in those systems serving the remainder of the plant is shown schematically in Fig. 1. In these systems the air is recirculated, and the proportion of outside air is under the control of a dewpoint stat in the chamber after the sprays; this stat also controls the amount of brine flowing through the precooler and the amount of steam to the injector. Since the air is recirculated no preheaters are needed and only a precooler is used. In this system, again, the flow of steam to the reheater is under the control of the room thermostat.

Novel Industrial Application of Direct Expansion Coils

An unusual use for modern air conditioning equipment in the form of direct expansion cooling coils has been found by a manufacturer of electric furnaces. Generally speaking, electric furnaces have two primary functions:

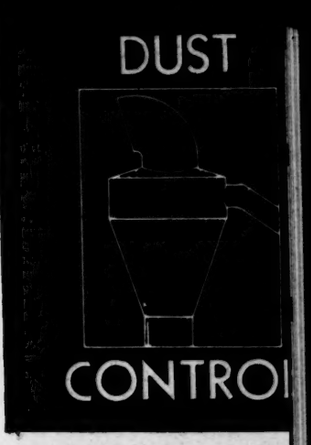
1. Reducing material—principally metals—to a molten mass.
2. Heating material—again principally metals—to a predetermined temperature, below the molten temperature, for treatment and processing.

For many modern processes, such as copper brazing and bright annealing, it is necessary to prevent oxidation of the material undergoing treatment. This can be done if a "special protective atmosphere" is kept in contact with the material for the entire time it is at an elevated temperature. The protective atmosphere is a mixture of inert and reducing gases made by partial combustion of various standard fuel gases. This gas is produced in a generator which is an integral part of the unit. The gas leaves the generator at approximately 1800° F. and as the combustion process also forms water the gas leaves the generator carrying a much higher moisture content than is desirable in the furnace.



In order to remove this moisture, the gas first passes over a series of water cooling coils where the temperature is reduced from 1800° F. to about 90° F. This naturally causes condensation of a considerable portion of the moisture, but not to the desired point. The gas is then taken through a direct expansion coil of 14 rows of tubes at a velocity of approximately 200 feet per minute. The temperature of the refrigerant in the coil (Freon) is maintained at 32° F., and the gas leaves the coil at about 40° F., practically saturated. When this gas mixture is injected into the furnace and expanded by the internal heat, the moisture content has been reduced to a point lower than the allowable maximum—because, of course, the gas is cooled to 40° F.

An ingenious control arrangement governs the pre-determined temperature selected below the molten temperature. The cooling coils comprise a regular refrigerator assembly which is a part of the complete furnace and is built in final form at the plant. However, the complete furnace is assembled on the job.—*F. Pederson.*



DUST CONTROL

in industry is dealt with in this series of three articles which outlines a program for a complete system of dust control.

By F. F. KRAVATH†

PART II—PIPE VELOCITIES FOR CONVEYING DUST. TYPES OF DUST FILTERS.

SINCE it is impractical in most cases where dust is generated to completely enclose the process and depend on the dust-tightness of the enclosure to prevent dispersion to the atmosphere — for the simple reason that if processes were completely enclosed, it would be impossible to operate most present day machines—it is then necessary to enclose the process as much as possible and provide a source of negative pressure to the enclosure. The pressure within the enclosure being less than atmospheric, air rushes into the hood where it is not enclosed, preventing dust from coming out. (The question of just how much air is to rush into the hood to prevent the dust from escaping will be taken up later under "Hoods"). Then, depending upon whether it is desired to exhaust the contaminated air in its entirety, or to attempt to precipitate out the greater percentage of air-borne material within the enclosure, is determined the position of the hood outlet and the velocity of the air stream within the piping. It can be seen that the problem from this point on is essentially one of conveying.

Proper Pipe Velocities

Let us examine the subject of pipe velocities from all angles. Let us review the many considerations involved and then let us draw a few conclusions.

In attempting to lift material vertically, it is necessary first to counteract the effect of gravity. This is accomplished by the pressure corresponding to the velocity of flow, namely velocity pressure, acting on the exposed surface of the material to be lifted. Thus if a ball of metal weighed one ounce and its diameter were one inch, it would require a force of one ounce acting on the effective surface of the ball, the cross-sectional area of 0.7854 sq. in., to support it without imparting to it any motion. Hence the velocity pressure corresponding to this force would be $1 \div 0.7854 = 1.275$ ounces per square inch, or converting to inches of water,

†Assistant Plant Engineer, Abrasive Company, Philadelphia.

PROFITS IN AIR

NO. 14 OF A SERIES DEALING WITH INDUSTRIAL PLANT ATMOSPHERIC CONDITIONS.

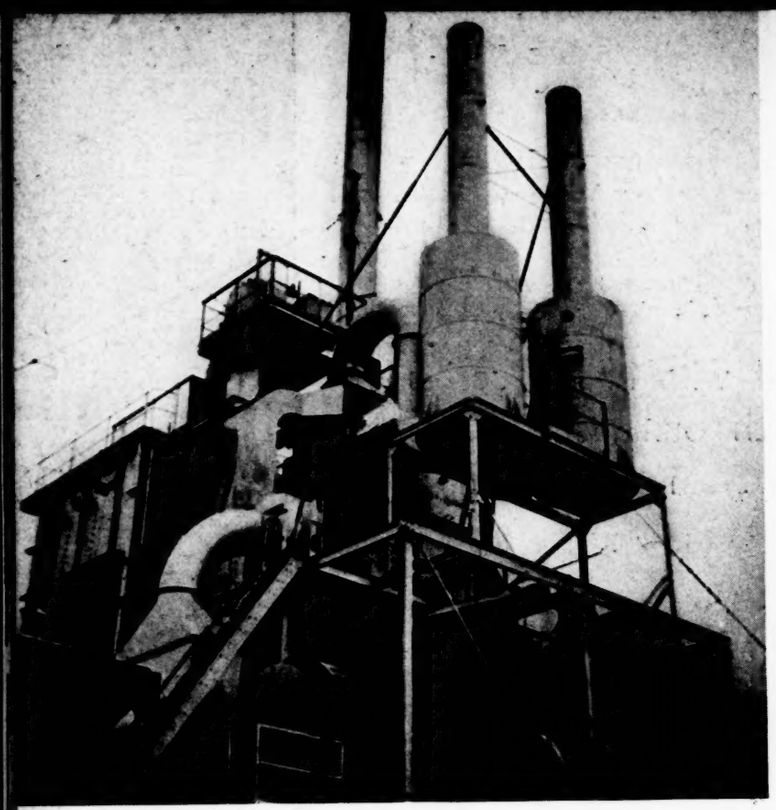


Fig. 3. Air washers for collecting fine dust from asphalt plant. (Washers at middle right.)

since one foot of water or twelve inches is equal to 62.4 pounds per square foot,

$$62.4 \text{ lb. per sq. ft.} = 12 \text{ inches W.G.}$$

$$\frac{62.4}{144} \text{ lbs. per sq. in.} = 12 \text{ inches W.G.}$$

$$1 \text{ lb. per sq. in} = \frac{12 \times 144}{62.4} \text{ inches W.G.,}$$

$$1 \text{ ounce per sq. in.} = \frac{12 \times 144}{16 \times 62.4} \text{ inches W.G.,}$$

$$\text{hence, 1.275 ounces per sq. in.} = \frac{1.275 \times 12 \times 144}{16 \times 62.4} \text{ in. W.G.,}$$

$$= 2.235 \text{ inches W.G.}$$

The velocity corresponding to a velocity pressure of 2.235 inches W.G. is equal to $4006\ (2.235)^{\frac{1}{2}} = 6000$ f.p.m. This velocity, however, is sufficient merely to sustain the ball or float it. If it is desired to lift this ball or convey it through 1000 feet of piping in 30 seconds (2000 feet per minute), it is necessary that the critical or flotation velocity be increased by 2000 f.p.m., thus making it 8000 f.p.m.

In conveying the same ball horizontally, different conditions apply. The velocity pressure, here, does not act to support the ball, but merely to drag it along the bottom of the pipe. Thus, if the same ball were at rest in a horizontal pipe, it would take a relatively small velocity to get it rolling. Assuming that the actual surface of the ball is such as to preclude its rolling, and it is necessary to drag or slide it in order to get it moving, then the force to be overcome is the frictional component of the weight of the ball. Since this component is a function of the surface roughness and attraction between the ball and the pipe and rarely exceeds 30 to 60% of the weight of the object, it is obvious that the velocity pressure and hence the velocity necessary to move the ball is considerably less than that necessary to lift it in a vertical pipe. The frictional component decreases to another value once motion is established, indicating a greater margin of safety.

Other points to be considered, however, are the fact that the surface of the pipe, as manufactured commercially is full of irregularities. Light sheet metal pipe will have rivets, screws, or welded seams periodically, while the elbow is a series of sections or pieces joining together at more or less abrupt angles. In order to insure against piling up of material at such irregularities, it is necessary to provide a margin of safety when designing for the proper velocity.

The ordinary practice is to use the same design velocity for both the horizontal and vertical pipes. The design velocity should be approximately 2 to 3 times the critical or flotation velocity, a good average being 2.5. For the movement of high concentrations of dust and dirt, it is best to use the higher limit, while when the concentration of material is relatively low, the lower limit is permissible. A concentration, by weight, of less than ten grains of material per cubic foot may be considered a low concentration, while a concentration of more than thirty grains should be considered a high limit. Between ten and thirty grains, the average figure of 2.5 may be used.

Another point to be considered is the degree of abrasiveness of the material being conveyed. Since it is obvious that larger and heavier particles will demand increased velocities, and at increased velocities material wear may be expected in transporting abrasive material, it is self-evident that the larger material should be dropped out at the hood, if possible, in order to prolong the life of the system. Materials which are non-abrasive, but have a tendency to clog or agglutinate should be allowed the higher multiple of the critical velocity.

Let us derive a simple expression for the correct transporting velocity and compare it with one formulated by DallaValle.

$$v = 4006\sqrt{vp} \quad \ldots\ldots (1)$$

where, v = critical velocity in f.p.m.,
and, vp = velocity pressure corresponding to v, in inches of water gauge,

$$\text{Also,} \quad W = \frac{\pi d^3}{6} \times \text{Sp. Gr.} \times \frac{62.4}{1728} \quad \ldots\ldots (2)$$

where, W = weight, in lbs., of particle sphere,
d = sphere diameter, in inches,
and Sp. Gr. = specific gravity.

$$\text{Also,} \quad F = vp \times \frac{1}{12} \times \frac{62.4}{1728} \times \frac{\pi d^2}{4} \quad \ldots\ldots (3)$$

where, F = force, in lbs., to sustain W.

$$\text{But,} \quad W = F \quad \ldots\ldots (4)$$

Therefore,

$$\frac{\pi d^3}{6} \times \text{Sp. Gr.} \times \frac{62.4}{1728} = \frac{vp}{12} \times \frac{62.4}{144} \times \frac{\pi d^2}{4} \quad \ldots\ldots (5)$$

Simplifying and cancelling gives

$$\frac{d}{6} \times \text{Sp. Gr.} = \frac{vp}{4}, \text{ or } vp = 0.667d \times \text{Sp. Gr.} \quad \ldots (6)$$

Substituting this value at vp in (1) gives

$$v = 4006\sqrt{0.667d \times \text{Sp. Gr.}} = 3280\sqrt{d \times \text{Sp. Gr.}} \quad \ldots (7)$$

Now let V = kv, where
V = the transporting velocity in f.p.m.,
and, K = a transporting factor.

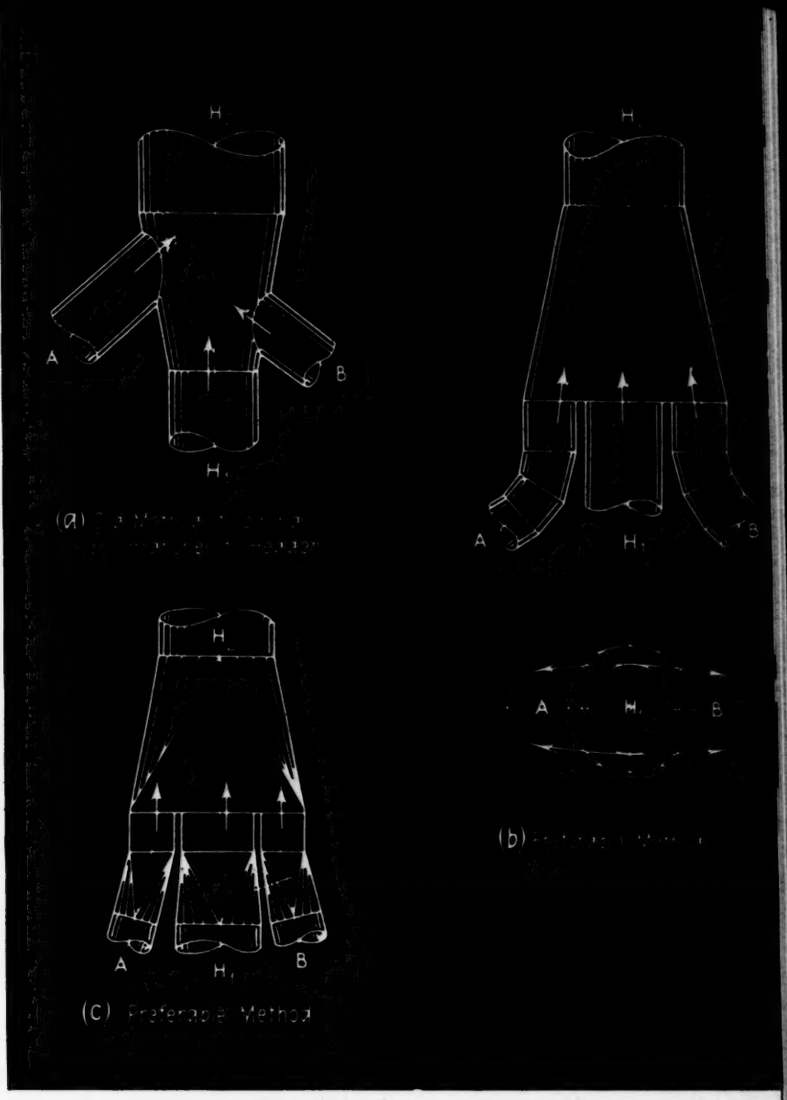


Fig. 4. Sketches illustrating methods of joining branch ducts to main or header.

Then, $V = 3280\ K \sqrt{d \times Sp.\ Gr.}$ .....(8)

Dalla Valle's expression for vertical transporting velocities is as follows:

$$V = 54{,}700 \left(\frac{S}{S+1}\right)\sqrt{p} \quad \text{.....(9)}$$

Where V = transportation velocity in f.p.m.,
S = specific gravity,
p = particle diameter in feet.

Let us examine equations (8) and (9) for a ball of 1 in. diameter with a specific gravity of 0.67.

Using Dalla Valle's expression, equation (9),

$$V = 54{,}700 \left(\frac{0.67}{1.67}\right)\sqrt{\frac{1}{12}}$$

$$= 6400 \text{ f.p.m.}$$

Using equation (8),

$$V = 3280 \times 2.5 \sqrt{1 \times 0.67}$$

(2.5, the average transporting factor is used for "K")

$$V = 6300 \text{ f.p.m.}$$

Thus it can be seen that for medium concentrations the velocity as figured by both methods will be almost alike. For low concentrations, equation (8) will indicate a lower transporting velocity, while for heavier concentrations, a higher velocity will be indicated. Where sliver-like (or non-spherically shaped) material is handled, it is best to use a value for "d", in the formula, corresponding to the smallest cross-sectional area, thus, regardless of the position of the material relative to the flow of air, sufficient velocity will be available adequately to transport it.

Since the volume of air to be handled by each branch will generally be determined right at the hood as the product of the hood opening or face in square feet and the velocity at that point sufficient to prevent escape of the dust or fume, this automatically indicates the proper pipe size. Its cross-sectional area will equal the quotient of the branch volume divided by the transporting velocity.

Following the procedure outlined will generally prove effective and satisfactory. In those exhaust systems, however, where the material is collected and then introduced in bulk form for further conveying, it is good practice to allow between 50 and 100 cu. ft. of air per pound of material conveyed. 50 cu. ft. or 3.75 lbs. of air at 70°, is sufficient when the transporting factor of 3 is used, while 100 cu. ft. is preferable where the transporting factor of 2 is used. Table 1 gives safe transporting velocities for various materials based on the average transport factor.

Some authorities on the subject hold that main pipe diameters should be increased, where joined by branch pipes, to the extent that the cross-sectional area of the main after the expansion piece is equal to 20% more than the sum of the cross-sectional areas of the branches up to that point. The writer can see no basis in fact for this assumption other than the crowding, shock losses, and eddy currents set up at such a junction.

TABLE 1—TRANSPORT VELOCITY—BASED ON AVERAGE TRANSPORT FACTORS

Materials Conveyed	Transport Velocity, F.P.M.
Gases, Fumes, Dusts in Brownian Motion ..	2000
Powders, Lint, Cotton Dust, Grain Dust...	2500
Cotton, Wool, Flax and Similar Materials in Loose and Dry Condition	3000
Light Shavings, Dry Sawdust	3000
Buffing, Light Polishing Dusts, Sander Dust	3500
Sawdust and Heavy Shavings from Damp Wood, Wood Chips, Heavy Buffing, Polishing and Grinding Dusts	4000
Tumbler Barrel, Sand Blast, Stone Plant Dust, Powdered Coal, Wood Blocks, Knots	4000
Rags, Dried Pulp, Cotton Seed, Oats	4500 to 5000
Lead Dust, Heavy Cuts on green lumber ...	5000
Wheat and Corn	5500 to 6000
Salt, Sugar	6500 to 7000
Sand, Cast Iron Borings.....	7000
Small Ashes and Ground Clinkers.....	8000 to 12,000

NOTE: Above information in general as printed in standard text and reference books. Where experience has shown other velocities to be advisable, writer has changed to figures shown.

Expanding the main to 20% greater than the sum of the branches minimizes these losses. Fig. 4 (a) illustrates such a method of joining piping. Fig. 4 (b) shows a much superior way of doing the same thing. While it is somewhat more expensive to make pipe connections such as shown in Figs. 4 (b) and 4 (c) (cost will be about 15 to 25% greater than for the old type connection) the saving in resistance to flow, and hence horsepower, will pay for the additional initial cost in a very short time. A well-constructed piece of either of these two types can reduce the resistance losses to approximately one-third of the loss encountered in a standard connection with 30 degree included angle between branch and main centerlines.

Once the material has been cleaned out of the air, it is unnecessary to maintain the relatively high transport velocities, and it is good practice to reduce the discharge pipe velocity to 3000 f.p.m., if there is some length to the pipe, and again shortly before discharging to reduce the velocity through a 7 degree included angle evase stack to as low as 1500 f.p.m. at discharge to the atmosphere. If the discharge pipe is relatively short, the evase stack may be attached directly to the fan discharge, making it possible to save almost the entire value of the velocity pressure, by converting it to static pressure. The subject of pipe velocities being so vitally important in the design of the exhaust system, the writer has gone into it a bit deeper than into some of the other phases.

Dust Filters

Of the various types of dust filters, each has its particular sphere where it performs its job very efficiently, very cheaply, and with a minimum of maintenance. The difficulty in attempting to accurately choose the proper filter for the proper job, is the reason for so many abject failures. We will briefly review the various types and indicate the suitability of each.

Gravity Filter or Settling Tank: This type, being nothing more than a large box, is simple to build although not necessarily cheap, due to the large amount of material involved. While the efficiency is dependent on the size, and by making it very large it can be made quite efficient, the cost and the room necessary would be prohibitive. It is most suitable as a scavenger or classifier in series with a more efficient filter. Its use here will be to remove the larger and heavier material from the air stream permitting a reduction in transporting velocity, increasing the life of the final filter, and giving a rough classification in size of collected material. It is especially of value in this connection where the material handled is abrasive in action.

Cyclone: The cyclone can also be constructed to give very high efficiencies, but only by materially reducing its life. This is done by using higher inlet velocities, smaller diameters, and various internal devices for trapping the dust, all of which spell increased maintenance. The high-efficiency cyclone is of value only on extremely non-abrasive materials. The cyclone is of great value as a classifier where both coarse and fine materials are being handled, and where the material is non-abrasive. Here, its initial cost is low, its job is well performed and its life is long.

Inertial Separator: This type of filter is of value principally in the scavenging of the larger and heavier air-borne material and serves the same function as the gravity filter with which it is sometimes combined. Beyond this service, its performance is unpredictable and its value doubtful.

Dynamic Precipitators: These fan-type filters are built in both the wet and the dry types and are by far the most economical, from an efficiency standpoint, of any of the types mentioned thus far. The more efficient wet-type precipitator approaches the cloth filter in efficiency of collection, while avoiding the necessity of purchasing a fan. From an initial cost standpoint this type of filter is generally cheaper than the cost of a cloth filter plus a fan. Where available water pressure is not high enough, a pump must be furnished to spray the wheel, while where recirculation is desired to save the cost of water, a wear proof pump is essential. Where the material to be handled is extremely abrasive, it is questionable whether this type of filter is the most economical from a wear standpoint.

Cloth Filters: The cloth filter is probably the most efficient of all filters available for ordinary exhaust work. Its cost, while somewhat greater than the cyclone, is nevertheless justified when considering the extremely high efficiencies of recovery possible when well adapted to any exhaust job. With the exception of extremely hot, wet, or sticky substances, the cloth filter is capable of handling almost any type of material and doing it well. Even the most abrasive of materials may be handled with low maintenance, when the inlet and filtering velocities are very low. (Inlet velocity should not exceed 1500 f.p.m. at entrance to filter and should be extremely well baffled to prevent tearing the cloth bags. Filtering velocities should not exceed 2.5 f.p.m.) Being large in area, and composed of a multitude of joints, it is difficult to prevent leakage of air and water inwards, as during a rain. Such a filter must be checked often to disclose torn bags. Leakage will be indicated by wet collected material. In general, it needs considerable attention.

The Air Washer: This type of filter because of its ruggedness, its high efficiency of collection (which approaches the cloth filter in efficiency), its freedom from wear and other maintenance, and its general simplicity has long enjoyed the writer's overwhelming favoritism. Its one big drawback was the initial cost which was as much as 50% more than a cloth filter of equal capacity. Only recently the writer's attention has been directed to a washer which is impervious to weather, has an efficiency of collection at least as high as any washer on the market, has all the other attributes of the washer, including its satisfying freedom from maintenance, and markets currently for approximately 50% of the cost of a cloth filter. In a system which the writer has installed the washer has been in use over one year and is handling the most abrasive materials commercially made. Where every type of filter ever installed in such service needed repairs within six months, the washer has functioned uninterruptedly over one year to date and has just worn the asphalt painting from the built-in cyclone at the washer inlet. Fig. 3 illustrates the simplicity, ruggedness, and compactness of a typical washer.

DRUG INDUSTRY

Novocol Chemical Mfg. Co.

producer of dental anesthetics, uses silica gel unit to dry air in pill-making room; maintains a relative humidity and eliminates spoilage by discoloration caused by moisture. Air conditioning also smooths out the production curve.

By RODNEY SANFORD†

PROFITS IN AIR

NO. 15 OF A SERIES SHOWING HOW INDUSTRIAL PLANTS PROMOTE PROCESSES AND PROFITS BY SCIENTIFIC CONTROL OF AIR CONDITIONS

IN none of the chemical industries is absolute control of every variable involved in every step of manufacture more important than in those industries producing medicinals and pharmaceuticals. High in the list of plant conditions which must be controllable to a nicety wherever compounds and solutions for the use of the medical profession are made or packed, is the air which circulates around the workers, the machines and the very product itself.

In the tablet room of the Novocol Chemical Manufacturing Co., Brooklyn, producer of local anesthetics for the dental trade and pioneer in more than one phase of oral anesthesia promotion and technique, the air conditioning requirements are particularly severe. Most successful production in this room requires a constant relative humidity of no more than 25% with a dry bulb temperature of 76 to 80F in thoroughly filtered air circulated at a rate of at least 10 air changes per hour. The Novocol installation constitutes the first application in the metropolitan New York area of the new continuous rotary silica gel dehumidifier, and one of the first applications of it anywhere.

The tablet room itself is L-shaped with four outside windows and two windows and one door in the plas-

†The Brooklyn Union Gas Co.

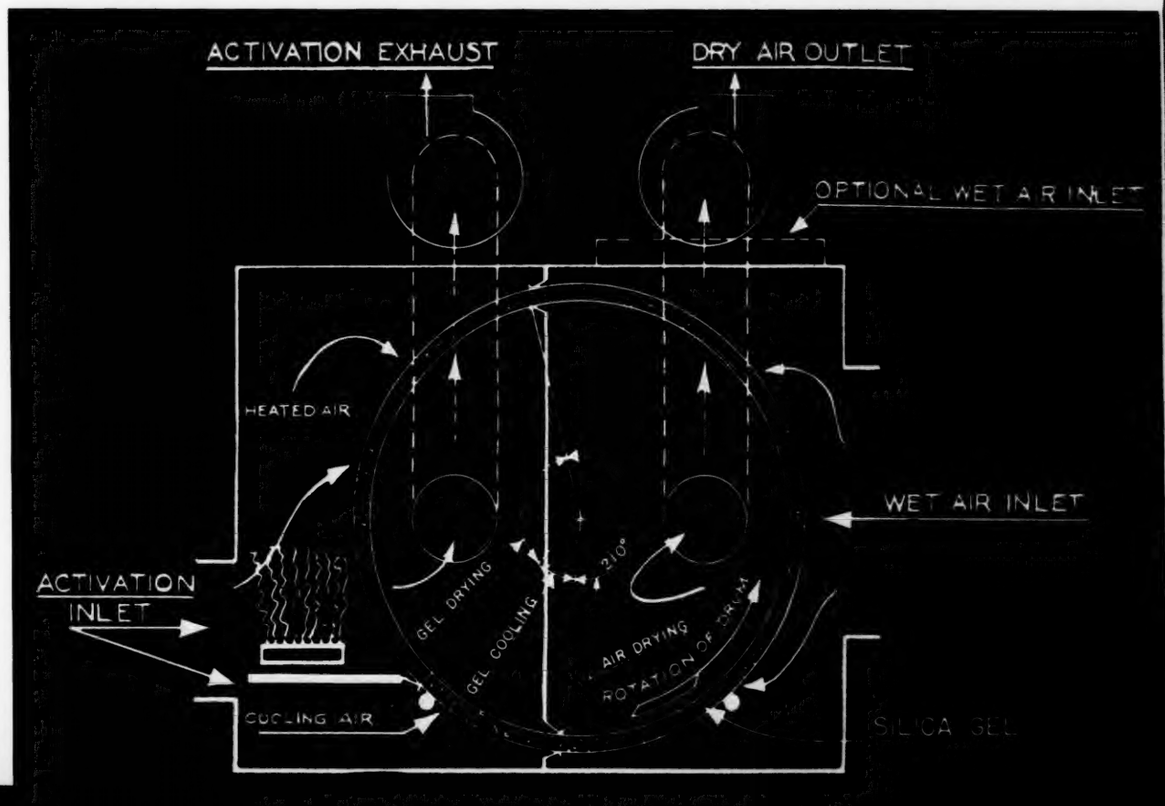


Fig. 1. Schematic diagram of the rotary type silica gel humidifier in the Novocol Chemical Manufacturing Company plant.

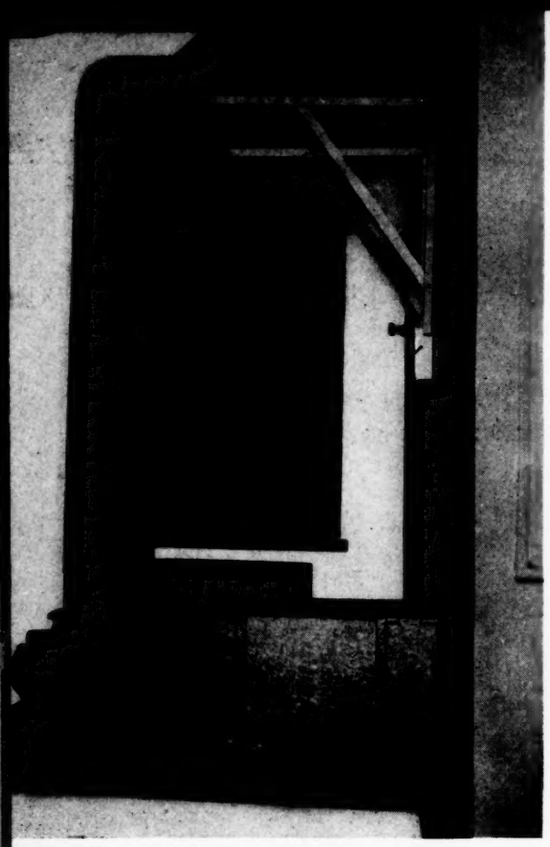


Fig. 2. (left) The dehumidifying unit located outside of the tablet room delivers 600 cu. ft. of dried air per minute when burning not over 130 cu. ft. of gas per hour. Fig. 3. (right) The Y duct through which the dried air is directed into the tablet room. Part of the exhaust register near the floor is shown in the lower left corner.

tered walls which set it off from the large production space in a corner of which it is located. Fig. 4 gives the main dimensions. Within the room are located five single-punch F. J. Stokes pill presses (4 driven by overhead shafting and one by an individual drive), one ball mill, and two laboratory benches laden with analytical equipment. Seldom are more than one machine operator and one laboratory worker in the pill room at any time.

The room is used for compressing solid procaine and monocaine tablets of (generally) one-third of a grain each. The principal market for the tablets is in the dental field, and, although their use with relation to ampouled anesthetics may be decreasing, the whole field of anesthesia is expanding so rapidly that tableted procaine is selling at a rate ahead of 1921. All tablets contain a certain amount of salt which cannot be dispensed with, but which is capable of rapidly absorbing moisture, and it is this salt content which makes it necessary to pill only in the presence of dry air. In all, the available output capacity of the tablet room is 150,000 tablets per day, and each machine is capable of producing an average of 80 pills per minute.

In the continuous rotary unit, the silica gel used for the adsorption of moisture reactivated for further use (after it has adsorbed its fill of water) by gas heat. This unit differs from previous apparatus, however, in that the silica gel is not arranged in trays which are intermittently and alternately used to dry the air passing through them, but is packed between curved sections of heavy wire mesh and mounted on a structural frame so as to form a large continuously-rotating drum or basket with silica gel beds about 1 in. thick forming its walls. This drum, shown in end-section in the schematic diagram, Fig. 1, is divided longitudinally near the center by stationary vertical baffles which split the dehumidifier housing into sealed halves. The drum makes one revolution in 9 minutes. Some 58% of the cylindrical gel bed (210° of the complete 360°) is always available for drying the wet air. Most of the remainder of the bed at any instant is in the process of drying out (or reactivation) by virtue of the forced passage of heated air through it, while a small portion at the bottom is being cooled down after reactivation so that it does not enter the drying zone while hot and thus add its heat to the air being dehumidified.

Important features of this unit are the continuity of operation, small space occupied by the unit, its relatively low cost and relatively low fuel consumption.

At Novocol, the dehumidifier is of a size to deliver 600 cubic feet of dried air per minute and do it with a maximum manufactured gas consumption of 130 cubic feet per hour. The unit, shown in Fig. 2, is located outside of the tablet room.

Its dry air outlet duct rises several feet above the dehumidifying unit itself, and then turns horizontally to pass the dehumidified air across the coils of a tap-water-cooled after-cooler and deliver it to the distributing ducts within the tablet room. Fig. 3 shows the Y duct by which the dried air is directed through two 8 x 10 in. registers into the tablet room, Fig. 4. Fig. 3 also shows the large exhaust register located near the floor. The exhaust duct fitted to this register delivers its air back to the wet air inlet of the dehumidifying unit, and serves to recirculate a very large proportion of all the tablet room air. An outside air inlet to the equipment is located below the window and obscured by the equipment itself in Fig. 2, while an exhaust for the heated air which reactivates the silica gel runs upward and out the top of the window. Tap water for the cooling coils is used at the regular city water temperature of 60F, and its rate of flow is regulated by a hand-operated valve. The humidistat which automatically controls the dehumidifying equipment is located 5 ft. from the floor on one of the tablet room walls. All the gas burners in the unit are automatically

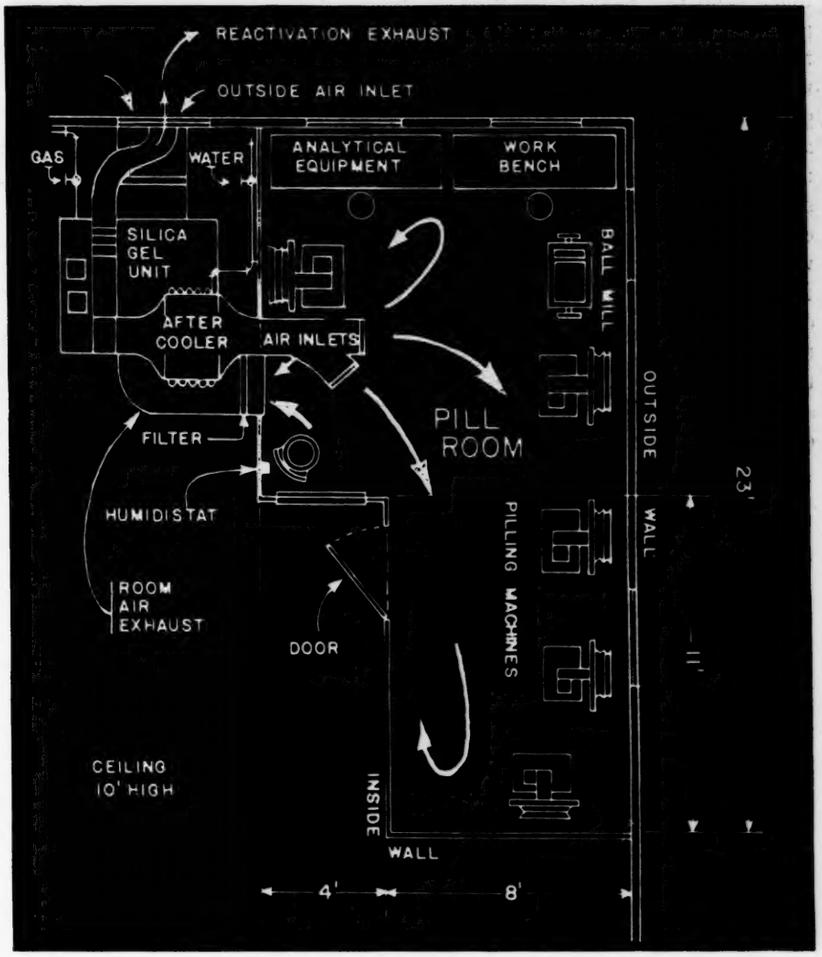


Fig. 4. Plan view of the tablet room showing the layout of the spaces involved, location and direction of air currents.

ignited when the humidistat calls for further drying effects, and are protected by the latest type of safety devices. Removable glass-wool filters are inserted in both the outside-air inlet and the recirculated-tablet-room-air inlet.

Two features of the installation are that: (1) totally independent control is provided for the moisture and temperature of the delivered air, and (2) the primary function of the unit is to dehumidify directly.

According to Dr. Samuel D. Goldberg, vice-president of the Novocol Company, the benefits of the installation are reaped in two ways: First, before the dehumidifier installation was made, production was necessarily intermittent, depending on the propitiousness of weather conditions. As a matter of fact, it was found necessary to get out the full year's supply of monocaine and procaine tablets between November and late February. Now, however, the tablet room can be run at any time desired and production schedules closely adapted to variations in demand. Obviously, smoother, more efficient, and less costly operation is obtained. The second benefit arises from the fact that it is no longer necessary to store packaged tablets before delivery for any great length of time. Before the dehumidifier installation was made, it was often necessary to store tablets for five to six months before distribution, and it was occasionally found that the product had discolored by this time and lost marketable value. In fact, all Novocol's products which are not vacuum packed are now delivered absolutely fresh to the dealer with the recommendation that they be kept on his shelves not longer than three months.

The operating cost of the installation are revealed in the following tabulation of hourly cost, which totals 13½ cents per hour:

Gas (130 cu. ft. per hr.)	7.8
Connected Load (0.5 Kwh.)	1.5
Cooling Water (210 gal. per hr.)	4.2
Hourly cost	13.5c

This is based upon the utility rates existing in the particular territory in which the plant is located.

Facts and Fallacies in Heating Piping

PART 1—CONNECTIONS TO MAINS

By T. W. REYNOLDS

FIRST of all we have a method commonly called good practice for such a long time as to frighten one from questioning it in any way, in fact it is presented in a most authoritative work as the preferred method. Reference is made to the method of taking branches from a main at an angle of 45 degrees in a one pipe steam heating system as shown at (a) in Fig. 1. Condensate from risers or first floor radiators, which is returned counter to the flow of steam along the bottom of the branch, is supposed to enter the main with a minimum of disturbance somewhat as shown, and without doubt no harm can come from this method of returning the water. In fact it offers slightly less resistance to the flow of steam than the method shown at (b), though more resistance than the method shown at (h) in Fig. 1.

Fig. 1 (b) shows a method which in the writer's opinion is superior to the one shown at (a), because it gives a perfect swing joint to riser or radiator connection without distorting the angle of the branch as is the case at (a). No one can find any premise for objection to this method when used on the last branch from the main, as no one cares whether steam gets cut off by returning condensate so that it cannot go beyond this point in the main, nor can any one object in cases where the condensation is dripped at the end of the branch into the return as indicated in Fig. 1 (c), but wherever condensate flows backward in the branch, objection is usually made that its entrance into the main cuts off the area of the main as shown at (b), so as to block the flow of steam to points beyond, yet does anyone know of any heating difficulty that was ever removed simply by removing such a connection?

It would appear that something is wrong with the picture at Fig. 1 (b) as water cannot jump through the air to the other side of the main, but rather will no doubt take the path shown at (d) with little if any disturbance, with the greater possibility it may flow back clinging to the sides of the branch and fitting in the main as sketched in Fig. 1 (e). Objection might be made to the reasoning of Fig. 1 (e) on the basis that the nipple does not project flush into the fitting, but if so one can still defend his position by reverting back to Fig. 1 (d) and comparing it with Fig. 1 (f) which presents a possible picture of what takes place in the method shown at (a), especially so where the main is large, say 3-in., and the branch only 1-in.

As much main area is cut off by the returning condensate in Fig. 1(f) as in 1(d), but in any event what harm is there in the water conditions of either method, for a glance at point X in Fig. 1(g) shows that we have plenty of other places in a heating system where the condensation is much more likely to cross the path of the steam, but where no hesitation is felt in using 90 degree connections, simply because there

A NOTE BY THE AUTHOR

Standard piping connections are slavishly reproduced and passed on from one author to another. Quite often they also form an impressive part of our plans and a sacred niche in the specifications. Here they receive most honorable mention before being passed on to the contractor, yet the advantage of many of these connections seems extremely doubtful. This, we do know: they serve but to increase the cost.

These so-called standard piping connections were not originated in this era, but are hangovers from opinionated ideas of long ago which having gained vogue are now hard to dispel. They show little or no change from those thirty years back, notwithstanding the rapid changes that are continuously taking place in practically all other phases of heating.

The need for each of these connections is commonly defended by certain assumptions, or by a line of reasoning which off-hand seems logical because the reasoning is not pursued far enough. Such reasoning might have had some justification in other days where water in pipes was a troublesome factor and when but little was definitely known of what actually took place inside a pipe or fitting. Today we have intensive research with glass pipes, colored liquids and with pipes whose arrangement may be quickly changed at will so as to produce any desired condition for experiment.

Experience acquired in contracting, as well as in trouble shooting over a long period of years at the rate of several trouble jobs per day, eventually caused the writer to show no hesitation in repeatedly violating with impunity many of these sacred traditions with no harmful results. With this in mind, the elimination of waste, and in some cases betterment of method, it is the writer's thought to present herein a number of changes in piping methods which the writer has found along with some others to be the better way. In general these piping methods refer to connections as used in a one pipe steam heating system. Connections common to other systems are so noted, or if not their application is obvious.

isn't anything else we can do about it. Having no other choice, there is no worry about it and it works. As shown in Fig. 1(g), there isn't any doubt but that a good percentage of the condensate coming down the riser must perforce exit at right angles at point X to every last bit of steam entering the riser at this point and what is worse the encounter takes place at a point where steam and water counter flow continues back through the horizontal branch, whereas in (a) of Fig. 1 the condensate enters the main and then flows along in harmony with the steam.

Conditions at the bottom of a rise to a radiator are theoretically not as bad as at the base of a riser; for example, a 1¼ in. vertical radiator connection supplying a 55 sq. ft. radiator will have 12% of the load to handle that a 2½ in. riser has supplying 464 sq. ft. of radiation, and this with a pipe area that is as much as 31% of that in the riser. Practically, however, the water from a single radiator is much more apt to be returned in spurts when first heating up than in a riser where all radiators do not heat and discharge their maximum water at the same time.

In the final analysis, consider for a moment how much water really comes back in a steam heating system to bother us. Take the extreme case, such as a 2½-in. riser supplying 464 sq. ft. of radiation, and allow 50% additional radiation because of piping and quick warming up load for which the boiler is sized. Given these figures, a little mathematics will derive a figure of a little more than one-third gallon of water per minute, or two tablespoonfuls of water per second; just a trickle the size of a lead pencil, as one will find even when he opens the end of the main return itself. Tests have shown that a cold radiator when first heating up can condense for a short time as much as two and two-thirds the preceding figures, providing the radiator is given all the steam it can take, but no boiler is sized for such a load, nor is the air eliminated from the radiator as fast as that.

If there are times when water collects and holds up to be returned at greater quantities than these figures show, it is only because of faulty design or unclean water and the effect will soon be over. It is said that foaming in boilers is again becoming prevalent, due to the chemicals now introduced into municipal waters. If this be so, it would seem that the trouble should be attacked at its source. In any event a foaming system cannot be operated successfully regardless of the type of connections used.

At (h) in Fig. 1 is shown a method occasionally used by the writer at certain points in a heating system, so as to keep the main well above the water line of the boiler, a method that is sometimes used by the most conservative of engineers, because he may find himself in a tight place where he has no other choice. He must believe that it will work out all right or he wouldn't use this method. Nevertheless, he refuses to believe in it where he has the choice of other methods, being in a similar position to the man who while usually disclaiming God sometimes prays to him upon dangerous occasions just to be on the right side.

This side connection method may save only a few inches in headroom, but every inch counts where you are otherwise below the usual prescribed limits of proper distance above boiler water line, and particularly counts when these inches, added to other inches saved by various other methods, become cumulative to the extent that the grand total of inches takes you out of a border line case, thus saving the expense of a boiler pit with its possibilities of waterproofing, rock excavation, and like problems.

The writer has often used this method, even as he has the one in Fig. 1(b) and has often encountered it here and there on mains in heating systems, both good and bad. If bad, the method of connection was blamed, and sometimes expensive changes would then be made in these connections, but wherever the real trouble is traced to its source such type of connection will give

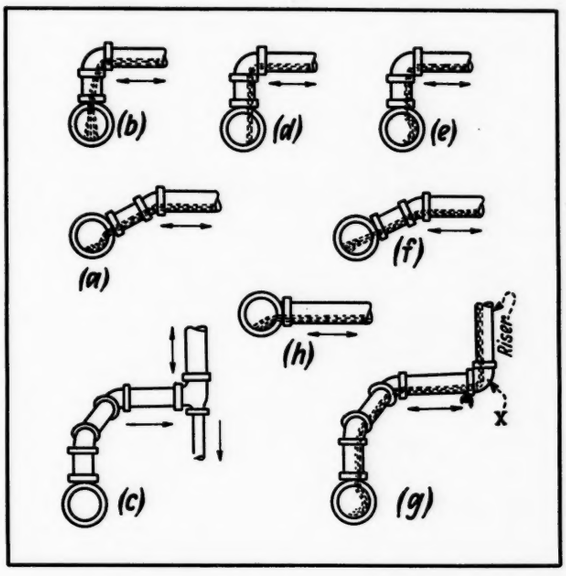


Fig. 1. Illustrating true water conditions in so-called good (f) and bad (d) (h) connections to mains of one pipe steam heating systems.

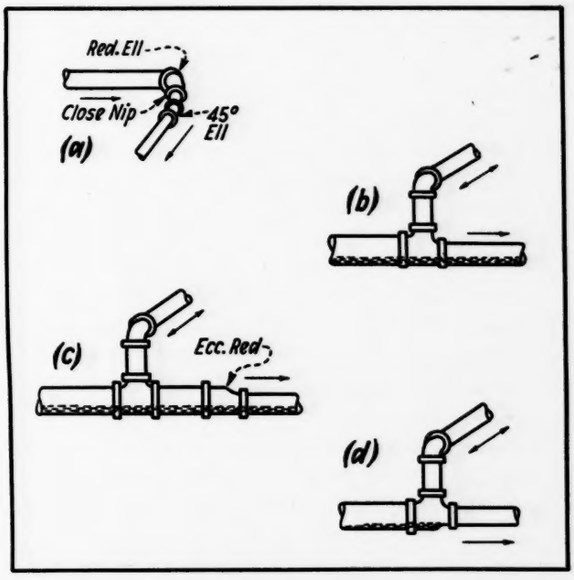


Fig. 2. Unnecessary methods of eliminating pockets in mains in comparison with results as obtained by means of an ordinary reducing fitting in the main (d).

no troubles of any kind; in fact such a connection gives least disturbance to water and steam at the point of connection.

Objection might be made to this method where the branch and the main are the same size, as sometimes happens with a large riser near the end of a main which is decreased in size as it goes along. In such a rare case, the pitch of the branch or main or of both, especially if increased slightly in amount, will prevent flooding of the branch; or again any other form of connection can be used in such cases as the end of any main would be well down from the ceiling. Any lack of provision for expansion in such a side connection will ordinarily be taken care of by the extra ells found in the usual runout, more often the ells that take the runout up and across the foundation wall to the main wall, but in any event the expansion in the average one pipe system is slight and can be taken care of in various ways if deemed necessary.

That the factor of water in one pipe steam heating systems is no longer treated with the alarm it once occasioned may be realized by consulting latest authoritative tables of pipe sizes which now give the same size for one pipe mains as they do for two pipe mains where the water is separately returned. In general, this means that one pipe size smaller can now be used, and this is quite a saving in the cost of pipe, fittings and covering. Smaller pipes also have less air to vent.

In former times the writer was so impressed by the water bugaboo and its effect on pipe size, that in order to effect a reduction in size of main without the aid of expensive eccentric fittings, he always tried to get the water out of the main as quickly as possible by taking advantage of some bottom outlet or necessary rise in the main which was dripped.

The reason why water cannot be any noticeable factor in well pitched pipes is that one cubic foot of steam in a low pressure heating system condenses into as little as one cubic inch of water, which is about the quantity of water returned in one second from 350 sq. ft. of radiation and distributing piping when first warming up. This means that the average house heating system of say 525 sq. ft. of radiation does not require at its maximum load more than 1.5 cu. ft. of steam per second nor return more than 1.5 cu. in. of water in the same time interval.

Giving the pipes of a one pipe system a good grade for free drainage is most important and much more important than any method of connection. For example, Fig. 2(a) shows the standard method of reducing a main by means of a reducing ell at a point where the main changes in direction, and at first glance this method of drainage looks impressive and ever so logical. Emphasis seems to be placed on the need for a most rapid pitch of the nipple to the 45 degree ell on the reduced size of the main, but further analysis discloses that this pitch might better be given to the larger size of the main where a slightly more than normal pitch would eliminate any necessity for the nipple and 45 degree ell. The pitch required to do this may be but the customary grade. At the most it need be only that required to prevent the interior shoulder of the reducing fitting from holding back enough water to cut down the cross sectional area of the main before some distributing point.

Standard specifications for main reduction where directional change does not occur frequently call for reducing fittings to be eccentric so as to keep the bottom of the main in the same plane, see Fig. 2(b), but as such fittings are expensive and difficult to obtain from stock, the method of reduction by means of an eccentric reducer, Fig. 2(c), came into greater favor. Such reducers are more readily obtainable and are theoretically better because the constriction in pipe area takes place at a safe distance from the distributing point; nevertheless they are still not as cheap or as easy to obtain as the more usual stock fittings and the labor involved by this method adds up the cost. There seems to be no

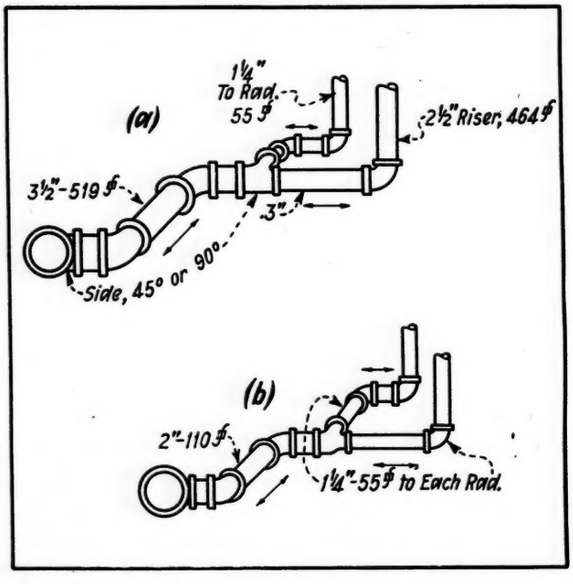


Fig. 3. Method of making one connection serve for two, called poor practice for a riser runout (a) but said to be correct for radiator connections (b).

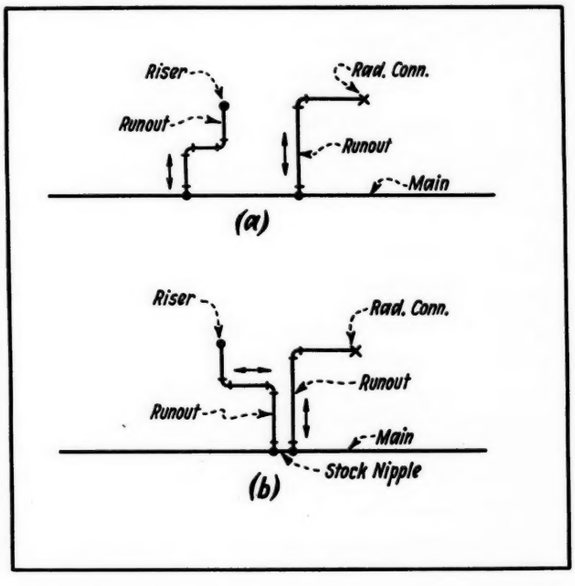


Fig. 4. Scattering the water and runout connections at points along the main (a) versus bringing the water and connections together at convenient points (b).

substantial reason why either method is necessary nor why a simple reducing tee, Fig. 2(d), will not answer the purpose where the correct pitch is given to the boiler side of the fitting, especially so where the reduction is only one pipe size, as is usually the case.

Fig. 3(a) shows a method of taking a first floor radiator connection from a riser runout, a method which is supposed to be bad practice as it puts water from the radiator back into a horizontal pipe which is said to have enough troubles of its own due to considerable counter flow of steam and water, yet no one hesitates to do the same thing when connecting one radiator branch from another as in Fig. 3(b). Comparative figures of the quantity of water likely to be returned in the same time per square inch of the two different pipe areas of the larger runout in each case, Fig. 3(a) versus Fig. 3(b), will prove that the conditions are about as watery in the one case as in the other.

Fig. 4(a) shows the draftsman's usual method of taking branches from the main, whereas this can be more cheaply done as in Fig. 4(b), thus making use of a stock nipple instead of adding labor as otherwise required for cutting and threading the main at intervals. Some object to introducing the water from two branches into the main at points so close together, but looking at the matter practically is there any difference in effect between a lone riser connection to the main of 600 sq. ft. capacity and two risers each of 300 sq. ft. capacity when connected to the main close together? In both cases the same quantity of steam and water is handled.

Note that in Fig. 4(a), the connections are taken off the main in the direction of flow in an effort to get the steam out of the main as soon as possible, though one could reason that it is if anything more desirable to keep the water out of the main as long as possible as in Fig. 4(b), but neither does this matter. The thing of more importance is to make use of stock nipples and thus give longer stretches of main uninterrupted by fittings, and therefore a main more quickly installed and insulated and possibly one in which fewer points of reduction occur.

A few dollars one way or other may gain or lose the contract on residential work, so the small contractor saves a few dollars here and there, finding it cheaper where headroom is available to pipe as in Fig. 3(a), 3(b), and 4(b), rather than to make a second connection direct to the main with its extra cost for a larger reducing fitting and additional cut and thread on the main. Curiously enough, while the small contractor on residential work usually takes full advantage of such piping methods, the owner on larger work seems not to receive the benefits which could be derived by these cheaper piping methods, because most estimators on large work figure so many dollars per runout, regardless of whether it comes direct off the main or is taken from another runout, and regardless of whether the connections are shown scattered along the main as in the usual draftsman's quick drafting method, Fig. 4(a), or brought together in so far as practical to do as shown in Fig. 4(b).

Effect of Altitude on Performance of Gas Appliances

The effect of altitude on the performance of gas burning appliances has long been a problem confronting the gas industry, states the *American Gas Association Monthly*. In the United States there are centers of population at altitudes ranging from sea level to five thousand feet above sea level or more. As a result, the barometric pressure under which gas is utilized will vary from approximately 30 to 24 inches of mercury. Several discussions and reports of test results dealing with this subject have appeared during the past several years, among them being Research Paper No. 553 of the National Bureau of Standards and a paper delivered before the Utilization Committee of the Pacific Coast Gas Association at its 1938 Convention by John C. Mueller and Louis C. Morris.

The National Bureau of Standards investigation was conducted in a specially constructed altitude chamber in which any desired atmospheric pressure could be maintained. As a result of this work on contemporary appliances, the American Standards Association decided that the input ratings of all approved appliances should be reduced at the rate of 5% for each 1000 ft. above sea level.

Recently, the American Gas Association Testing Laboratories were authorized to make a further study of this subject. It was decided to make comparative tests at or near sea level and at some high altitude.

Lake Arrowhead, California, having an altitude of 5130 ft. above sea level, was selected as a suitable location for the work. The Pacific Coast Branch of the A.G.A. Testing Laboratories, located at 250 ft. elevation, or approximately sea level, was selected for basic comparative tests.

Tests were first conducted at the Pacific Coast Branch to determine the maximum rate at which the appliances employed could be operated without producing in excess of the allowable carbon monoxide concentration at normal gas pressures. The appliances were then transported to Lake Arrowhead, without change, and similar tests conducted at the higher elevation.

Tests were conducted on two gas ranges, two radiant heaters, two circulators, one vented, the other unvented, a floor furnace and a gravity-type basement furnace.

It was found that the average reduction in maximum input rates per 1000 ft. increase in altitude required to maintain safe performance was 4.2%. The maximum decrease required was 6.6% (radiant heater No. 2) and the minimum 2.5% (range oven No. 1.). Accordingly, the 5% reduction in input rate per 1000 ft. increase of elevation which has been adopted for application to all appliances on the basis of the work conducted at the National Bureau of Standards appears to be satisfactory.

Automatic Heating Controls

By CHARLES O. RADDEN†

A summary of the different methods of automatic control for use in connection with steam heating in order to maintain comfortable conditions without opening windows, turning off radiators, or banking fires, followed by a description of the three general types of such controls—intermittent, steam temperature and modulating.

IN order to heat any building satisfactorily, it is necessary to provide both a properly designed and functioning heating system and a source of heat of ample capacity.

However, even with proper design and capacity, while desired temperatures may be obtained in the coldest weather, there is the possibility that in other weather, comfortable conditions may not be obtained. Except in the coldest weather, building temperatures may be higher than desired unless there is provided some method of restricting the heat supply. Since the average heating requirements may be half the maximum requirements and since maximum heating conditions may occur only one or two days a year, some form of heating control is indispensable to economical and satisfactory operation. In Boston, the usual heating system design temperature is zero, the normal daily temperature in January is 27F, and during half the heating season, the daily normal temperature is between 42F and 65F, the rest of the season between 42F and 27F.

However, some form of control is usually employed either by building occupants opening windows or turning off radiators, or by the janitor letting his fires die out. While such operation protects occupants from extremely uncomfortable conditions, ideal temperatures are rarely maintained. Accompanying the often excessive temperatures are high bills for heat and attendance.

If automatic controls are installed with steam heating systems, they usually utilize any or all of three distinct functions. Heating controls may:

(1) *Operate intermittently* by turning heat on and off for periods of varying duration as determined by outside or building conditions.

(2) *Vary radiator temperatures* by maintaining steam pressures (or vacuums) to supply heat at varying rates.

(3) *Vary amount of steam entering radiator* by changing pressure drop across system with resultant change in flow through fixed orifices at radiator inlets.

These control functions are combined as a rule; systems operating on vacuum may operate intermittently in mild heating weather because of limited range of temperatures occurring under vacuums; orificed heating systems may be operated intermittently if pressure modulating equipment is not available; or orificed systems may be operated under vacuums. In spite of this overlapping in actual use, heating controls will be considered under the three general headings: (1) Intermittent Controls, (2) Steam Temperature (Vacuum) Controls, and (3) Modulating Controls with Orifices.

Intermittent Controls

Controls of this type may be on individual radiators, or zones, or on entire system.

(a) *Individual Radiator Controls*

The most common type of individual radiator control is the thermostatic valve, the radiator valve having a thermostatic element or heat motor mounted on it. The element feels air temperature close to the radiator and indirectly feels room temperature.

Power-operated diaphragm valves controlled by room thermostats may turn steam on and off to individual radiators. This type of equipment permits accurate control of room temperatures, but requires a source of energy. Although ideal results may be obtained by individual radiator control, the number of pieces of equipment required is great.

(b) *Zone or System Control*

The entire heating system may be split into any number of separate heating systems or zones, or may be controlled from one central location. Zoning is usually considered when sections of the building vary in hours of occupancy, in temperature desired, or in exposure.

A building may be zoned by distributing steam at a high pressure to each zone with separate control valve and pressure-reducing valve or by distributing steam at heating pressures with on-and-off valves at each zone. In any case, the same type of control may be used to operate control valves for zoned or centrally controlled systems.

The control valves may be operated intermittently with electricity or air by means of timing devices, room thermostats, outside thermostats, or combined radiator and outside temperature sensitive controls.

Air-operated valves function by having air act against a diaphragm or bellows attached to the valve stem. An air-thermostat permits pressure to build up or leak off from the diaphragm and open or close the valve.

Electrically operated controls may work through motorized valves, direct-acting solenoid valves, pilot-line solenoid valves, or heat motors. With the motorized valves, some solenoid valves and heat motors, the force is applied directly to the valve stem

†Boston Edison Company.

to open or close. In other cases, the solenoid valve opens or closes a bleed-off in the control valve pilot line causing high pressure steam to open or close the main valve.

The controls themselves operating the above equipment may be timers, indoor or outdoor thermostats, or compound temperature sensitive devices feeling both indoor and outdoor temperatures. The timers usually are clock mechanisms on which a daily schedule may be set for cold, medium, or mild weather. The different daily programs are manually changed as the weather changes. Timers may also be of a type permitting different ratios of length of *on* and *off* periods of heat. This control is set manually during the day according to outside temperature. Such controls have the disadvantage of feeling neither inside nor outside temperatures and being dependent upon manual changes. However, high limit or low limit thermostats may be used in conjunction with this equipment to prevent overheating or freeze-ups.

The simple thermostat, used to operate control equipment, shuts steam off when desired temperatures are reached. Simple thermostats controlling entire heating systems or zones must be located in rooms where rates of heating and cooling are characteristic of the building as a whole. This means avoiding drafts, sun, cold walls or pipe shafts and abnormal heat gains in order to insure satisfactory operation.

Outdoor thermostats may consist of a roof box containing some type of heating element to which heat is supplied while the building is being heated. This roof box is installed and set to heat and cool at the same rate as the building or zone. In order to vary the amount of heat delivered to the building, it is necessary to vary the heat delivered to the roof box.

A third type of thermostatic intermittent control consists of an element mounted on the radiator and an element mounted on the outside of the building. This type of control can be set to maintain a radiator temperature consistent with outside temperatures. The frequency of the intermittent cycles may also be adjusted by variation of the location of the temperature sensitive bulb.

In general, the satisfactory operation of intermittent controls depends upon the nature of the heating system. If it is not possible for the system to relieve itself quickly of air, the nearest radiators will be overheated while the most remote radiators will remain cold. With short heating cycles, return lines and radiators must be vented quickly to heat uniformly. With long heating cycles, during the *off* period, some rooms will drop below desired temperatures and heating complaints will result.

Steam Temperature (Vacuum) Controls

By varying the temperature of the steam in the radiators, the amount of heat delivered to the system can be varied. The weight of steam delivered at a constant differential will also vary with the density. With this type of heating, the control is effective only when the temperature is below approximately 40 degrees for a system designed for zero degree outside temperature. The limits of this type of control are the vacuums and pressures that can be carried on the heating system. If a constant differential is maintained across the system, a control valve varying the initial pressure on the heating system will vary the heat input to the rooms. Such a control may be effected by manual operation of vacuum pumps and reducing valves by having the engineer check his pressures and differentials against outside temperatures. To control such a system automatically, a modulating or positioning type of valve responding to an inside temperature and radiator temperature control is required. The vacuum pump is controlled to maintain the differential between the pressure at the supply valve and the pressure at the vacuum pump. When outside temperatures are higher than will permit control by increasing the vacuum, the system may operate intermittently or, if orifices are installed, the pressure differential may be decreased.

Modulating Controls with Orifices

The third way of controlling building temperatures is to vary the weight of steam delivered to each radiator as determined by outside temperature requirements. This is frequently done by inserting a flow restricting orifice at the inlet of each 2-pipe radiator and varying the pressure differential across the orifice. In order to vary this differential, some type of control valve must be employed that will permit adjusting initial pressure as determined by the outside control. However, very satisfactory operation can be obtained by manual changing of the reducing valve according to an outside temperature-heating pressure schedule.

The modulating control valves used may be similar to those used with a vacuum differential control system; that is, positioning valves or heat motor or air-pilot operated valves. A recent development in control valves consists of a simple intermittent control valve with duplicate pilots and solenoids so that steam may be delivered at one of two pressures or may be shut off completely. A modulating valve operated through a heat motor may be set to cut off at any number of fixed pressures. From 2 to 20 different heating pressures may be obtained through heat motor control valves although the operation may not be strictly modulating.

A simple form of control for the pressure modulating system consists of 2 simple thermostats; the first set to maintain the maximum initial pressure, while the building is below, say, 71F. Between 71F and 72F some intermediate pressure will be delivered to the system and when a temperature of 72F is reached, the control valve will shut off completely. This maintains temperatures in a building between 71F and 72F and pressure on the system is varying between the maximum and some lower initial pressure.

More elaborate controls make various contacts to the heat motor or positioning valve as determined by outside temperatures (and in one case, wind pressure on the building). For any specific outdoor temperature, the desired circuit is completed and a specific pressure is maintained on the heating system. Another type of outside control varies the resistance in a circuit which is balanced by another resistance which is varied by the steam pressure. This control maintains a balance between outside temperature and delivered pressure.

EDITORIALS

Dusts and Fumes

Nowadays with proposals for socialized medicine being made and with proposals for public financing of hospitals being discussed, we hear much about health hazards generally. With all this discussion too little attention is devoted to those particular health problems which arise in factories as a result of dusts and fumes in the air breathed by workers. Because of this lack of attention it is especially interesting to note the report of the 1939 activities of the Division of Industrial Hygiene of the New York State Department of Labor. This division has but lately been equipped with modern apparatus for studying the effects of dusty and fume-laden air on employees and with means of securing adequate air samples from workrooms. Also the general problem of air-borne industrial hazards has been assigned to the division.

One of the most interesting features of the report is its emphasis on problems other than those which have come to be associated with silicosis. The prominence given to the silicosis hazard in the public mind because of lawsuits and spectacular events in rock-drilling, seems to have generally obscured the existence of many other occupational hazards arising out of air contamination. The report enumerates various industries in which dusts of non-silicious nature are also hazardous. So also are dangerous fume conditions encountered. With the rise of the chemical industries there are more and more of these situations where workers in factories come into contact with dangerous concentrations of fumes in the air.

Here is a whole field of effort where engineers can play an important part, where the problems are still challenging, and where there is likely to be a steadily widening demand for better and better practices and equipment.

Modern Pioneers

In our March issue we printed an account of the meetings held throughout the country late in February to celebrate the 150th anniversary of the American patent system and to bestow recognition as Modern Pioneers on outstanding living inventors. To some it may have come as a surprise that so many of those singled out for this mark of distinction were connected with our industry. So far as we can learn no other industry furnished more of the honored names than ours.

To those of us who are actively engaged in the field, most of the names selected are well known as are the inventions for which they are honored. Many of us not only know the names but the individuals as well. Probably still more of us are on familiar terms with the equipment produced as a result of these inventions. To us these men need no mark of distinction other than their works. To the great public however there is little knowledge of the men responsible for the inventions whose results the public enjoys. Let us all take pleasure in seeing these associates of ours selected for public recognition in the hope that the public generally will get to know them better, even as we ourselves do.

Engineering in Distribution

Questionnaires recently addressed to both the wholesale-contractor and the distributor-dealer groups who to a large extent act as the final contacts with the ultimate purchasers of equipment produce the information that between 80 and 90% of these firms consider themselves organized to handle any necessary engineering connected with their business. While these estimates of ability to handle engineering are made by the firms themselves and may not necessarily agree with estimates made by others, still the reports have some interesting and important aspects.

For one thing they tend to impress the point that a certain amount of technical ability is necessary at the point of installation and use of equipment regardless of all efforts to eliminate it. It is extremely doubtful if many firms can long sell, install or service successfully under present conditions without a considerable amount of this ability, although the ability may be supplied by manufacturers' engineers, or by independents just as well as by men employed full-time by the distributing firm itself. There is no uniform practice in this, but there is more and more tendency for the distributor-dealer to recognize the necessity of providing himself with good technical ability within his own organization. The older organizations of the wholesaler-contractor market channel have long recognized this and these arrangements have been part of their make-up.

Another point is that the firms in both of these marketing channels are slowly coming to resemble each other more and more in function, in organization, and in outlook. Here and there they resemble each other so closely that there is really no distinction between them. Generally, however, they still differ sharply in their methods of soliciting business and in their detailed operations. In spite of these differences there is some reason to believe that the time will come when the surviving firms handling the equipment of this industry will be welded into a fairly uniform group. This is a development much to be desired as going a long way toward solving the truly chaotic distribution problems which have proved such a headache during recent years.

Still another indication to be drawn from the returns is that slowly but surely an adequate group of firms is building on a secure foundation based on adopting a realistic view of their functions and of how to operate profitably with conditions as they now exist. There is less of the attitude of sighing for the good old days of the booming 20's on the one hand or of naively believing that the magic of public acceptance of air cooling will produce automatic profits on the other. One point seems assured—we now have a larger and better equipped group of distribution firms than ever before. Moreover, the trend is toward further improvements.

ABSTRACTS of Current Papers, Books and Pamphlets

Opportunities in Air Conditioning

For some time there has been a need for a book which would give young men an unbiased picture of the opportunities in the air conditioning and refrigeration field. During the past few years many young, and some not so young, men have been attracted to these fields by promises that here was a new industry which they could enter after a few months of study, obtain a job at a comfortable salary and have steady interesting work.

While there is some truth in these statements, there is also another side of the picture which the hopeful young man rarely learns about until he tries to find a job to fit the picture that was painted for him. Much time and money could be saved by these young men if there was available a source of information which would give an unbiased picture of the field.

This book undertakes such a task and up to a certain point succeeds very well. It presents a clear picture of the scope of these fields, particularly in regard to history, fundamental principles and types of positions open. The author's style is well suited to a book of this kind, being quite readable and avoiding technical language.

The principal weakness of the book is that it fails to point out the difficulties of securing a position in these fields. The reader certainly does not learn that employment is secured not by the mere taking of a short course in refrigeration and air conditioning but by either a technical college education and a factory training course or a rather long apprenticeship combined with a considerable amount of study. For this reason the book can be recommended only to those who have some way of learning about the other side of the picture.

[*"The Next Great Industry," by L. K. Wright. Published by the Funk & Wagnalls Company, New York, N.Y. Cloth bound; 5 x 7½ in.; 194 pages. Price, $1.50.*]

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Graphic Presentation

In 1914 Willard C. Brinton published a book of what was by far the most complete collection of examples and descriptions of the various kinds of graphic charts in use at that time. This was published under the title of "Graphic Methods for Presenting Facts." Although this book gradually became somewhat obsolete in sections, it nevertheless still remained the most comprehensive example of graphs ever collected.

Now Mr. Brinton has revised his 26-year old book, and the revised book includes examples of charts which he had been collecting ever since the previous edition. The revision is entitled, "Graphic Presentation, 1939," a book which is remarkable for the highly numerous examples included, for the extensive use of color, and for very valuable sections on the methods of manufacturing graphs and reproducing them.

The book is well organized and includes chapters on charts covering genetics, organization, relationship, flow, sector or pie charts, bar charts, maps, contour maps, distorted maps, charts on chronology and progress, log charts, frequency and correlation charts, three-dimensional models, and sections on the use of cameras, lantern slides, color, methods of reproducing and printing, paper and binding. Color is profusely used.

Altogether, the author has done an encyclopedic job, and probably the only criticism—and that perhaps a minor one—is that the section on pictorial unit bar charts, or pictographs, is not so well done as the importance of the subject would seem to warrant. This form of presentation which received its greatest impetus abroad, beginning about 1920, is now being widely employed in this country. No examples of the work of Modley, probably the principal exponent of pictographs in this country, have been included, and this is unfortunate since his work on pictographs is, generally, far superior to any similar work in this country. In spite of this rather minor criticism, the book is undoubtedly, an outstandingly practical and useful reference book on graphic presentation.

[*"Graphic Presentation," by Willard C. Brinton, consulting engineer. Published by Brinton Associates, New York City. Red fabricoid cover with gold lettering; 6¼ x 9¼; 512 pages; printed by off-set, with numerous pages in green, red, and blue; graphic end papers are included. Price, $5.*]

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Warm Air Heating

To a considerable extent the rapid progress of the warm air heating industry can be laid to the 22-year old cooperative research program of the National Warm Air Heating and Air Conditioning Association and the University of Illinois. Therefore any new publications on this work are of considerable interest to heating men.

This latest bulletin reports mainly on oil fired furnaces and room temperature distribution—two very live subjects. The conclusions of the investigators are interesting because they justify certain practices of field men and because they point out some new methods of improving the performance of this type of heating system.

For example, the oil burning furnace sold as a unit was found to be more efficient than the conversion job —the test house installation showing a net reduction in fuel oil consumption of 11.5 lb. per day and a net reduction of electrical energy of 0.2 kw. hrs. per day.

It was also shown that it is more economical to operate the oil burner for long periods with a low rate of combustion than to have a high combustion rate and allow the burner to operate for short periods.

Another method of increasing fuel economy was to increase the quantity of air circulated. Incidentally, this also increases the capacity of the furnace and improves comfort conditions.

Ordinarily an increase in the CO_2 percentage in the

flue gas is taken to indicate that there has been an appreciable increase in the efficiency of the furnace. That this is so only to a minor extent in certain cases is shown by this report. Whenever the flue gas temperature is low—500F or below—an increase in CO_2 content results in only a slight increase in efficiency. This means that if the furnace is designed with sufficient effective heating surface to give a low flue gas temperature, then the unit may be expected to perform satisfactorily even under diverse conditions of installation in the field.

A method of reducing the fuel bill by 5% or more was pointed out in connection with the tests on automatic draft regulator dampers. If these dampers are connected so that they draw air during the period when the burner is shut down from the outside rather than the basement the warm basement air is not wasted up the chimney and fuel savings of 5% or more will result.

Reduction of room temperatures from 72F to 60F during the night, showed savings of from 7 to 11%. This compared with a calculated figure of 9.4% as determined by the ASHVE Guide method.

The use of a two-speed fan in place of single speed fan resulted in an improvement of comfort conditions particularly in the first floor rooms where it not only resulted in higher room temperatures but in lower temperature fluctuations during each fan cycle. The total operating cost was found to be the same under both methods of operation.

The report also indicated that a reduction in the temperature difference between the breathing level and the floor may be effected by the use of storm sash, by the circulation of larger volumes of air at lower temperatures, and by use of registers which deflect the air towards the floor. The investigators found that the use of a deflecting type of register, located in the baseboard, gave results which were markedly better than those obtained with registers of the perforated grille type used in the same location. The investigators also reported that there was little doubt that by the proper application of the deflecting type registers some of the problems arising from the variation in room temperatures may be avoided. They recommended that the application of this type of register should be given especial consideration in houses that are not well protected against heat loss, and in rooms having excessive exposure and rooms located in the first story.

[*"Investigation of Oil-Fired Forced-Air Furnace Systems in the Research Residence," by Alonzo P. Kratz and Seichi Konzo. Engineering Experiment Station, Bulletin series No. 318. Published by the University of Illinois, Urbana, Ill. Price, 90 cents. Limited number of copies available for free distribution.*]

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Acoustics in Air Conditioned Enclosures

In his preface, the author states that, "although every engineer realizes the importance of noise problems when designing heating, ventilating or air conditioning systems, he is usually compelled to resort to judgment backed by past experiences in dealing with sound questions since complete sound data for most equipment is lacking." To help these men the author has condensed and clarified in this book the large mass of information on acoustics.

Beginning with a definition of sound, Mr. Kunen explains sound velocity, frequency and intensity. Considerable space is devoted to a description of the decibel scale. Cases similar to those encountered in actual practice, such as sound problems in a theater, are worked out in equations to illustrate applications of the decibel scale.

An explanation of loudness, loudness levels, reverberation time and room absorbing powers is followed by tables of absorption coefficients for materials and surfaces found in building interiors. Application of these tables makes it possible for the air conditioning engineer to determine the sound absorbing characteristics of the room or structure where an installation is contemplated.

Methods for computing the loudness level of Anemostats installed in typical enclosures serve to illustrate sound absorption problems. The booklet also contains three graphs for use in computing sound levels of small, medium and large Anemostats.

Mr. Kunen gives four common sources of noise in air conditioning systems. These are (1) blower and motor, (2) mechanical refrigeration equipment, (3) air flow through duct system, and (4) air outlets. A description of the type of sound created by each of these sources is followed by a brief recommendation for its reduction.

The book concludes with a table of typical loudness levels (in decibels), and absorbing powers (in sabines) for various enclosures normally encountered by the air conditioning engineer. Loudness levels given in this table range from 20 decibels found in some broadcasting studios to 100 or more decibels found in certain factories and engine rooms.

[*"A Treatise on Acoustics in Air Conditioned Enclosures," by Herbert Kunen, M.E., published by the Anemostat Corporation of America, New York, N. Y. Paper cover; 5¾ x 8½ in.; 28 pages with a number of charts. Price, $1.*]

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Sheet Metal Welding

This is a booklet on the fundamentals of sheet metal welding and includes an instruction outline for welding light-gauge sheet and tubing.

The booklet covers such subjects as design factors, the control of expansion and contraction, the use of jogs, the eldability of the material, and the welding procedure. It should be of particular interest to all fabricators of light-gauge metal, whether sheet metal or light-wall tubing.

Also included is a supplementary outline for teaching the welding of sheet metal and tubing. Recommended as a brief, to-the-point aid for instructors in welding schools and colleges, the outline contains suggestions for lectures, demonstrations, shop work, and study references for thirty lessons.

[*"Sheet Metal Welding Fundamentals," published by the Linde Air Products Company, Unit of Union Carbide and Carbon Corporation, 30 East 42nd St., New York, N. Y. Paper cover; 8½ x 11 in.; 16 pages. Available on request.*]

Variation in Skin Temperature

Measurements of skin temperatures (on forehead, hand, and back) of many persons, made during a 13 months' study by the German Office of Health, show a dependence of this temperature on climate conditions at the moment of measurement. Apart from personal differences, it is possible to show that certain changes in the skin temperature correspond to some extent to the changes of the temperature in the atmospheric and room air. Especially pronounced is the relation between the skin temperature and the so-called "coefficient of comfort feeling" which is the quotient of air temperature and cooling coefficient (as measured by the dry Kata thermometer). These tests indicate the importance of this coefficient from the physiological point of view. The author is of the opinion that this coefficient is to be introduced as far as possible into the measurements of climate and comfort feeling.

[*"Skin Temperature Changes in Different Year Seasons and Their Importance for Comfort Feeling," by W. Liese in Gesundheits-Ingenieur, June, 1939, page 345. Published by Verlag R. Oldenbourg, Munchen 1, Brieffach 31, price 0.75 RM, approximately 30 cents. Abstracted by Dr. Stephen Zamenhof.*]

BRIEF REVIEWS

Wood Fuel. Results of tests conducted on two Swedish and one Canadian wood burning hot water boilers. Swedish boilers required firing at about six-hour intervals as against two-hour intervals for the Canadian boiler but were about 10 to 12% less efficient, more liable to tar formation and more expensive. On the other hand, they were better constructed and required less attention for successful operation. [*"Summary of Tests on Three Domestic-Type Wood-Burning Hot Water Boilers," by C. E. Baltzer and E. S. Malloch. Published by the Bureau of Mines, Department of Mines and Resources, Ottawa, Canada. Paper cover; 8 x 14 in.; 12 pages. Available on request.*]

Controls. A discussion of automatic central control of heating plants. [*"Automatic Central Control of Heating Plants," by A. Nessi, Chauffage, Ventilation, Conditionnement, 1939, page 15. Published by Association des Ingenieurs de Chauffage et Ventilation de France, 19 rue Blanche, Paris, France IXe. Reviewed by Dr. Stephen Zamenhof.*]

Industrial Ventilation. Paper describes the portable gas interferometer which is an optical instrument used in industrial hygiene surveys for determining the amount of contaminating vapor in air. Discusses the application of this device to industrial hygiene surveys and gives a simple method of calibration and simplified data for the computation of vapor in air concentration for 40 compounds. [*"Calibration and Use of the Gas Interferometer," by F. A. Patty. Published in the Journal of Industrial Hygiene and Toxicology, November, 1939, pages 469 to 474, by the Williams & Wilkins Company, Mount Royal and Guilford Aves., Baltimore, Md. Price, single copies, 75 cents.*]

Federal Construction. This booklet was written primarily for firms and others entering into contract with the Federal Government for construction work or for the furnishing of supplies. Its purpose is to point out, in a general way, the principal things that should be known and observed in the preparation of a proper record of facts arising in the performance of Federal contracts. [*"Matters of Procedure Under Government Contracts," by O. R. McGuire. Published by the Fidelity and Deposit Company of Maryland, Baltimore, Md. Paper cover; 5 x 8 in.; 80 pages. Available on request.*]

Roof Temperatures. A progress report of a study undertaken to determine to what extent sheet steel roofs absorb solar heat, what portion finds its way into the building, and how much is reflected. This report gives some preliminary observations. [*" A Study of Temperatures Under Sheet Steel Roofs," by Henry Giese, W. D. Scoates, and N. C. Ives. Agricultural Engineering, published by the American Society of Agricultural Engineers, St. Joseph, Mich. July, 1939, pages 267 to 270. Price, single copies, 30 cents.*]

Heat Transmission. A reprint of three lectures on heat transmission given by Dr. Max Jakob at Purdue University, on November 30 and December 1, 1938. The topics of the lectures were: fundamental laws of heat transmission; decisive properties of matter, and typical methods. [*"A Survey of the Science of Heat Transmission," by Dr. Max Jakob, research series No. 68. Published by the Engineering Experiment Station, Lafayette, Indiana. Paper cover; 6 x 9 in.; 58 pages. Price, 25 cents. A limited number of copies are available without charge.*]

Research. A directory of the New England research agencies and consulting services and colleges and universities. This booklet is designed to assist New England manufacturers and other New England business executives in locating professional counsel and other assistance outside their own companies. [*"Directory of New England Research and Engineering Facilities." Published by the Engineering Societies of New England, Inc., in cooperation with the New England Council, 175 Tremont Temple, Boston, Mass. Paper cover; 6 x 9 in.; 118 pages. Price, $2.*]

Tobacco Drying. A report of an investigation to determine the most satisfactory conditions to cure bright leaf tobacco from the green to the most favorable cured state. [*"Drying and Curing Bright Leaf Tobacco with Conditioned Air," by Albert H. Cooper, Carl D. Delamar, and Henry B. Smith. Published in Industrial and Engineering Chemistry, pages 194 to 198, February, 1940. American Chemical Society, Room 706, Mills Building, Washington, D. C. Price, single issue, 75 cents.*]

Coal Storage. A discussion pointing out the factors most concerned in a spontaneous heating of coal. [*"Spontaneous Combustion of Coal," by O. P. Hood. Information circular 7074. Published by the Bureau of Mines, Department of Interior, Washington, D. C. Paper cover; 8½ x 11 in.; mimeographed; 5 pages. Available on request.*]

NEWS OF THE MONTH

Pittsburgh Code Group Dissolves

PITTSBURGH—Three months after it was directed by Federal Court to dissolve "forthwith," the Voluntary Code of the Heating, Piping & Air Conditioning Industry for Allegheny County has taken the necessary legal steps to wind up the affairs of the ill-starred corporation.

Attorney Paul J. Heenan filed in Common Pleas Court recently a petition for a decree of dissolution in accordance with his signed pledge to Federal Judge F. P. Schoonmaker last Dec. 8 when the Voluntary Code was broken up by consent injunction as a climax to a Federal anti-trust investigation.

Seventeen of the remaining 30 contractor members of the Code voted unanimously at a special meeting to move for the dissolution. President William J. Graham certified the enabling resolution.

The Voluntary Code was incorporated in 1937 as a non-profit corporation with the charter purposes of encouraging fair trade practices and sound business policies, standardizing materials and methods, improving the character of work done and labor employed and, generally, smoothing out the wrinkles of the industry.

Government lawyers conducting the U. S. Grand Jury investigation of high building costs charged that, in practice, these charter purposes established for Code members the same "closed shop" which the AFL Steamfitters' Union enjoyed in the labor market.

Heating System Broadcasts News

CAMBRIDGE, MASS.—Harvard students have a distinctive radio broadcasting system, the waves being sent out over the underground network of steam heating pipes from the central plant to the University's Harkness house group and to the scattered dormitories. The broadcasting job was undertaken by the Harvard Crimson just after the Easter vacation, with a daily program of classical and swing music, sports summaries and forum discussions. William Tyng is chairman of the board in charge. Eventually there will be programs by Harvard dramatic clubs and concerts by bands with commentaries on the music, and news commentators from time to time. Although the steampipe network is not perfectly grounded, no trouble is expected in the technical transmission, because the pipes as they are will convey the waves energetically enough to reach all receiving sets within the university area. By using this method the cost of buying new antenna sets is avoided.

Radiant Heating Will Increase Geisecke Tells ASHVE

LOS ANGELES — The prophesy that radiant heat, now used only in rare instances in the United States, would be the favorite type of heating employed in the more luxurious American homes and buildings of the future, was made by Prof. F. E. Geisecke of Texas A and M College, president of the American Society of Heating and Ventilating Engineers, at a dinner meeting of Los Angeles chapter, on March 19.

Co-guest of honor with the national president was Dr. C.-E. A. Winslow, New Haven, Conn., vice chairman of the national society's committee on research.

Prof. Geisecke's talk at Los Angeles centered on installations of radiant heat now in use in Europe, principally in Switzerland. His lecture was illustrated with slides showing the principles of radiant heating and illustrating some of the better European installations.

The fundamental principles of radiant heat, Dr. Geisecke explained, are based upon a concept of a flow of energy through space in which are found certain wave lengths of this energy which have the ability to warm any surface upon which the waves impinge. The amount of heat, the speaker declared, depends on the type, color and some physical characteristics of the surface.

Dr. Winslow reported on the work of the ASHVE Research Committee, outlining some of the outstanding projects upon which work is now being done. He also touched briefly on the work being accomplished at the Pierce Laboratories at Yale University in researches into the physiological aspect of air conditioning. He declared that the Pierce Laboratories are engaged in a study of the relationship between body metabolism and the heat content of the surrounding air. Dr. Winslow pointed out that thus far most of the fundamental principles of this relationship were not well known to scientists and engineers but that the work was well on the way to ultimately presenting the industry with complete and useful data on this subject.

Approximately 75 members and guests of Los Angeles chapter attended the special meeting to hear the two national officials. Arrangements for it were made by chapter program committee chairman Arthur J. Hess. Frank Park, president Los Angeles chapter, presided. Prof. Geisecke and Dr. Winslow were introduced by Dr. W. L. Halverson, head of the Pasadena City Health Department.

A.C. Men Discuss Code of Ethics

BUFFALO, N. Y.—The advisability of a code of ethics for members of the Air Conditioning Council of Western New York was discussed by Executive Secretary Walter P. Davis at a meeting of the Council in the University Club here March 26.

Mr. Davis read to members a code now being used in another city, emphasizing methods used in the preparation of bids. "I believe we need a similar code in Western New York," said Mr. Davis. The proposal was referred to the Summer Air Conditioning Committee for further action.

Edwin R. Cooney, president of the Council, announced the election of D. J. Peterson of Minneapolis Honeywell Regulator Co., as a member of the board of directors of the Council to succeed Lars Hedstrom, resigned.

Guest speaker for the evening was F. J. Kurth of New York City, vice president of Anemostat Corporation of America, who gave an interesting talk on air diffusion.

Contractors to Meet in New York

NEW YORK—The Heating, Piping and Air Conditioning Contractors National Association will hold its 51st annual convention at the Hotel Pennsylvania here May 27-29. Robert D. Williams is the chairman of the national convention committee. Four sessions in the Hotel Pennsylvania are planned for Monday and Tuesday, with the fifth and last session to be held Wednesday morning at the World's Fair.

The committee on apprenticeship, under the leadership of William V. Hoier, Chicago, will report to the convention on the preparation of text material for the apprentice training courses, and the committee on welding will report on setting up a standard procedure for electric arc pipe welding.

Air conditioning and trade promotion will be a subject for considerable discussion, while the introduction of I.B.R. ratings on cast iron boilers will make the report of the committee on boiler output of more than usual interest.

Oil Burner Men to Draw Up Standards

BOSTON—Members of the Boston Oil Burner Associates have voted to draw up a set of standards in an effort to regulate themselves and thus forestall any legislative action that might adversely affect the industry. The president of the organization is empowered to appoint one person to consult with the various firms and draw up the standards, to be threshed out in committee and then submitted to the membership for final approval.

Fleisher, Hertzler Address Boston Air Conditioning Group; Discuss Research and Hotel Air Conditioning

CAMBRIDGE, MASS.—Members of Massachusetts chapter of the ASHVE and the Air Conditioning Bureau of Boston held a joint dinner meeting March 19, at Walker Memorial, M.I.T. Guest speakers were Walter L. Fleisher, first vice-president of the national society, and J. R. Hertzler, general representative, York Ice Machinery Corporation. Mr. Fleisher's subject was "Research in Air Conditioning and Application of Findings to Practical Problems," while Mr. Hertzler addressed the gathering on "Hotel Guest-Room Air Conditioning."

In his talk Mr. Fleisher described how, over a period of 21 years, the ASHVE has spent about $600,000 on fundamental research, investigating comfort and health and the materials and apparatus required to produce results, in air conditioning. It has been found in these investigations how much heat the human body gives up in the forms of sensible and latent heat—how much fresh air is required —the effects of odors and noise—savings which can be made with the application of insulation in both winter and summer — what conditions are dangerous for health—the effect of air motion on comfort—and where heat sources originate—how they are dissipated.

Mr. Hertzler discussed the results of an extensive survey and analysis of past and present practices relating to hotel air conditioning installations in various sections of the country, digging into the economics of the entire problem of hotel air conditioning, the types of equipment and designs of installations as affected by climate and weather, types of building construction, outside air supply and comfort standards and the attitude of hotel managers toward air conditioning.

An acceptable standard of air conditioned hotel guest room varies with the guest, he said, while the economic considerations are equally variable and as deserving of study as guest comfort and acceptance.

"The first hotel to establish air conditioning, in a given locality, will receive a quicker return on its investment than the last hotel to fall into line, and continued installation in competitive hotels of a given community might well force the hand of the non-air conditioned hotel as a measure of self-preservation. He mentioned instances of hotels that were 95 per cent occupied already, which installed air conditioning, and another instance of a hotel which increased its rates because of air conditioning and replaced permanent guests who moved out with transients willing to pay the higher rate, the increased rates paying for the entire installation in less than two years, at the same time forcing competitors to install air conditioning.

In presenting his analysis, a group of eight hotel installations was considered. These included one house each in Washington; San Antonio; New Orleans; Kansas City; Yuma, Ariz.; Jackson, Miss.; Houston and Beaumont Texas; varying from the smallest in two cases of only four rooms conditioned, to 450 for the largest installation.

Lehigh Coal Meeting Plans Proceed

BETHLEHEM, PA.—Rapidly approaching completion of what is expected to be the most interesting and informative meeting of its kind yet held, are the plans for the Third Annual Anthracite Conference to be held at Packard Laboratory, Lehigh University, May 9-10.

Subjects to be covered include: Proper Use of Domestic Sizes of Anthracite in Home Heating, Modern Methods for Handling Coal and Ash, Practical Results from the Use of Anthracite on Semi-Industrial Stokers, Important new Data and Research on Chimneys and Draft, Reducing the Cost of Manufacturing Anthracite Equipment Through Industrial Standardization, Mining and Combustion Engineering as an Opportunity for the Young Engineer and Mineral Wool Insulation from Anthracite Ash and Anthracite Culm Banks.

6174 Hp. Added to New York A.C.

NEW YORK—According to the Consolidated Edison Company of New York, 74 air conditioning installations were connected to the company's lines in Manhattan during January and February. These installations total 5710 hp. and include 65 room coolers with a capacity of 38½ hp. The same company reports the connection of 14 air conditioning installations, totalling 278.6 hp. in Brooklyn; 4 installations, totalling 151½ hp. in the Bronx, and 8 installations, totalling 34.6 hp. in Queens during the same period.

Y.M.C.A. Appoints A.C. Instructors

NEW YORK — Two air conditioning engineers have joined the faculty of the New York Y.M.C.A. Schools Trade and Technical Division. Harry L. Baker, graduate of the Georgia School of Technology and Cullen E. Parmelee, graduate of the University of Illinois. The course to be conducted by Messrs. Baker and Parmelee is the Air Conditioning Course, of three months duration, which began March 25th, meeting on Mondays, Wednesdays and Fridays from 7:30 to 9:30 P.M.

Industrial Doctors to Meet in N. Y.

CHICAGO — The 25th annual meeting of the American Association of Industrial Physicians and Surgeons, together with the 1st annual meeting of the American Industrial Hygiene Association, will be held at Hotel Pennsylvania, New York, June 4-7. This will be a four-day convention intensively devoted to the problems of industrial health in all of their various medical, technical, and hygienic phases, with particular stress on prevention and control of occupational hazards. Important programs have been prepared, and technical and scientific exhibits will be a feature.

The dinner on Thursday evening, June 6, will be the occasion of the presentation of the Wm. S. Knudsen award for the year of 1939-40.

All who have an interest in these phases of industrial health, including industrial hygienists, safety engineers, chemists, plant engineers and personnel managers, are urged to attend as this program will have unusual value to all these groups.

Factory Building Continues High

TRENTON — New Jersey industrial building activity is continuing at the high record level sustained during the past several months, according to the latest report here by State Labor Commissioner John J. Toohey, Jr.

Seventy-eight plans calling for total expenditure of $962,659.74 were approved by the state labor department during February. This number is nearly three times the average for the last 20 years, and the valuation is approximately 138% above the average cost of construction for the same period. The February plans also marked the largest number approved during any corresponding month in the last two decades, the next highest being in February, 1920, when the total reached 73. The current report shows 45 more plans than for February, 1939, and the current valuation is $643,275.24 above last year.

Winnipeg Chapter Hears James

WINNIPEG, MAN. — The Winnipeg chapter, ASHVE, turned out almost to a member at the February meeting in the Fort Garrey Hotel, to hear John James of New York, technical secretary of the parent ASHVE speak on "What Research Means to Better Comfort, Efficiency and Health."

The speaker claimed that home owners will soon be able to have single unit air conditioning systems installed which will condition their homes both in winter and summer. Experiments now being performed in connection with the sterilization of air by ultraviolet rays and the filtration of air through electrostatic precipitation were also explained and discussed.

Germ Death Ray is Used in A.C.

BOSTON—There are two novel applications of the ultra-violet ray sterilizing lamp in commercial air conditioning systems in New England, perhaps the only applications of their kind in the country. One is used on the "Aroostook Flyer," two trains of de luxe coaches operated by the Bangor & Aroostook Railroad between Bangor and Van Buren, and on four other coach trains with connections for Portland and Boston. The other application is in a new small movie house, the Telepix Cinema.

The ultra-violet sterilizer on the trains consists of a fused quartz lamp arranged for operation on 32 volts. One lamp in each car is placed directly over a doorway and so arranged that the re-circulated air passes through the area thus protected. Mounting is in an aluminum re-circulating air box or plenum, the inner surfaces of which are highly reflective.

This air purification design was developed by the Sturtevant Company with the aid of W. F. Wells and M. W. Wells of the University of Pennsylvania. The ultimate hygienic effect is said to be the same as replacing the re-circulated air with the same volume of fresh outside air.

The Telepix Cinema seats 250 people, and is believed to be the only theater in the world to have ultra-violet ray lamps combined with its air conditioning system. The system employs six sterilizing tubes in a special chamber between the fresh air and return air ducts. Area conditioned includes the auditorium, foyer, manager's office, projection booth and re-wind room, storage, candy sales booths and retiring rooms. The air conditioning system, installed by Lawton Engineering Company and engineered by E. E. Burritt, includes filtering, dehumidifying and cooling the air by means of a 10 hp. compressor in the basement beneath, supplying 3600 c.f.m. of fresh air from an intake 20 feet above the sidewalk level. The entire system is automatic except for manual starting and stopping. Winter heating is by district steam. The ultra-violet lamps for sterilizing re-circulated air were the idea of the owner and not a part of the original system.

Chicago Adds 1313 Tons of A.C.

CHICAGO—20 central plant air conditioning installations were added to the lines of the Commonwealth Edison Company during February, according to a report from the air conditioning department of that utility. These central plants total 1303 tons and 1608 hp. In addition, 8 room cooler installations, totaling approximately 10 tons, were installed during the month.

Smoke Losses Held Easy to Stop

BOSTON — There is no sound excuse for the 100-ton blanket of soot which is spread over each square yard of Boston territory every year by chimneys, claims Professor C. Harold Berry of Harvard. He declares that this tremendous smoke screen is largely the result of ignorant or careless use of fuels, particularly in apartment buildings. William G. Hinckley, retired engineer of the Filene Company, under whom the first photo-electric eye system in Boston for detecting smoke came into use, adds to this, saying: "It is my candid opinion, after eighteen years of engineering that smoke can be virtually eliminated from the stacks of Boston without any heavy outlays of capital.

"Inexperienced firemen, poor oil, poorly adjusted burners, faulty boilers and dirty chimneys all contribute to the smoke nuisance, which is costing apartment and industrial concerns considerable in lost heat and power. And in some instances of smoking chimneys, all that is needed is for janitors to pay attention to their fires. It is possible to burn soft coal and poor oil without smoke if the engineer knows what he is doing. Although it may be expensive to repair or replace a faulty boiler, it is only through education that the apartment house owner can be made to see that in the long run he loses money in heat and apartment occupancy through his failure to comply with smoke inspection laws."

Air Raid Shelters Are Discussed

TORONTO, ONT.—The March meeting of the Ontario chapter ASHVE, was addressed by Cyril D. Tasker of the Ontario Research Foundation, Toronto, and a member of the Advisory Research Council of the ASHVE, who spoke on "Air Raid Shelters." His address which dealt with the types of construction used in England, and methods of ventilating and gas-proofing, was listened to with great interest by the large number of members and guests. Analysis of types of poison gases used in warfare and methods of filtering these to protect the air in shelters was also discussed.

Pittsburgh Chapter Visits Lab.

PITTSBURGH — The local chapter of the ASHVE met March 11 at the ASHVE Research Laboratory at the Bureau of Mines. F. C. Houghten, director of the Laboratory, spoke on The Society Research Program and The Problems Now Under Investigation. He pointed to the opening of the Laboratory in 1919 and told of the research work undertaken during its inception along with a description of the present studies.

1939 A.C. Exports Up 27% Over '38

WASHINGTON—Shipments abroad of American air conditioning equipment in 1939 were valued at $2,134,655, a gain of 27% over the corresponding trade in 1938, the machinery division of the Department of Commerce reported March 18. Self-contained air conditioning units comprised about one-third of the trade in both years, and other types the remaining two-thirds.

Exports of air conditioning equipment to Asiatic markets last year totaled $947,925, representing 44% of the total shipments to all countries, and a substantial gain over the corresponding shipments in 1938, which were valued at $613,872. Iran was the best export customer during 1939, taking shipments valued at $288,126, compared with $95,403 in 1938. British India was the third best market, U. S. exports to that country totaling $190,249, compared with $154,646 in the preceding year. Shipments to other important Asiatic markets during 1939 were as follows: Netherlands Indies, $118,232; British Malaya, $82,135, and Philippine Islands, $51,189.

Window Sashes Subject of Meeting

BUFFALO—The artistic advantages of wooden window sashes can now be enjoyed without the disadvantage of air leakage arising from painted window jambs and hand-installed weather stripping, Prof. Francis J. Linsenmeyer of the University of Detroit told the Western New York chapter of the ASHVE, at a recent meeting here.

The answer is a factory-built unit—a frame provided with an all-metal jamb into which the sash is fitted under shop conditions of precision. For the noisy, grating mechanism of sash-weight and pulley is substituted a heavy spring of which the tension can be adjusted to fit the weight of the window, also part of the unit, according to Prof. Linsenmeyer.

Another effect of the infiltration of cold air through windows, the driving out of moisture from the interior atmosphere of a room, also is reduced by the new window, the speaker said. Other advantages listed were easier sliding by eliminating of paint on jamb, resiliency of jamb to allow for expansion and contraction, and noiseless operation. The speaker declared these conclusions were the results of comparative tests.

Charles Arthur White

PHILADELPHIA — Charles Arthur White, secretary-treasurer of the Leeds & Northrup Company, died March 2 at Germantown Hospital after a 2-week illness. He was fifty-eight. His wife and son, Charles, Jr., survive.

UNIT VOLUME CAPACITIES AND DIMENSIONS OF STANDARD PIPE AND TUBING

TABLE 1—CARRYING CAPACITY (VOLUME) OF STANDARD PIPE AT VARIOUS UNIT RATES OF FLOW

Nominal Diam., In.	Standard Weight Iron Pipe (Actual Inside Dimensions)				Type L Copper Tubes (Nominal Inside Dimensions)				Velocity of Flow		
									One Foot Per Min.	One Inch Per Min.	One Inch Per Second
	Diameter		Area		Diameter		Area		Volume Flowing		
	Inches	Feet	Sq. In.	Sq. Ft.	Inches	Feet	Sq. In.	Sq. Ft.	C.F.M.	C.F.M.	C.F.M.
1/8	0.269	0.0224	0.057	0.0004	.....	.....	.....	.....	0.0004	0.0000333	0.0020
1/4	0.364	0.0303	0.104	0.000722	.....	.....	.....	.....	0.000722	0.0000602	0.00361
3/8	.....	.....	.....	.....	0.430	0.0358	0.145	0.001007	0.001007	0.0000839	0.00503
	0.493	0.0411	0.191	0.001333	.....	.....	.....	.....	0.001333	0.000111	0.00665
1/2	.....	.....	.....	.....	0.545	0.0454	0.2333	0.001620	0.001620	0.000135	0.00810
	0.622	0.0518	0.304	0.002111	.....	.....	.....	.....	0.002111	0.000176	0.01055
3/4	.....	.....	.....	.....	0.785	0.0654	0.4340	0.00336	0.00336	0.000280	0.01680
	0.824	0.0687	0.533	0.003701	.....	.....	.....	.....	0.003701	0.0003084	0.01850
1	.....	.....	.....	.....	1.025	0.0854	0.8250	0.005729	0.005729	0.0004774	0.02864
	1.049	0.0874	0.864	0.00600	.....	.....	.....	.....	0.006000	0.0005000	0.03000
1 1/4	.....	.....	.....	.....	1.265	0.1054	1.257	0.008729	0.008729	0.0007274	0.04364
	1.380	0.1155	1.495	0.01038	.....	.....	.....	.....	0.01038	0.0008650	0.05190
1 1/2	.....	.....	.....	.....	1.505	0.1254	1.779	0.01235	0.01235	0.001029	0.06175
	1.610	0.1342	2.036	0.01414	.....	.....	.....	.....	0.01414	0.001178	0.07070
2	.....	.....	.....	.....	1.985	0.1654	3.094	0.02149	0.02149	0.001790	0.10745
	2.067	0.1722	3.355	0.0233	.....	.....	.....	.....	0.0233	0.001942	0.11650
2 1/2	.....	.....	.....	.....	2.465	0.2054	4.772	0.03314	0.03314	0.002762	0.1657
	2.469	0.2057	4.788	0.03325	.....	.....	.....	.....	0.03325	0.002770	0.16625
3	.....	.....	.....	.....	2.945	0.2454	6.812	0.04730	0.04730	0.003942	0.2365
	3.068	0.2557	7.393	0.05134	.....	.....	.....	.....	0.05134	0.004278	0.2567
3 1/2	.....	.....	.....	.....	3.425	0.2854	9.213	0.06400	0.06400	0.005332	0.3199
	3.548	0.2957	9.886	0.06865	.....	.....	.....	.....	0.06865	0.005721	0.34325
4	.....	.....	.....	.....	3.905	0.3254	11.976	0.08317	0.08317	0.006931	0.4158
	4.026	0.3355	12.73	0.0884	.....	.....	.....	.....	0.0840	0.007367	0.4420
5	.....	.....	.....	.....	4.875	0.4062	18.665	0.12962	0.12962	0.01080	0.6481
	5.047	0.4206	20.006	0.1389	.....	.....	.....	.....	0.13890	0.01157	0.6945
6	.....	.....	.....	.....	5.845	0.4871	26.832	0.1863	0.18633	0.01553	0.9316
	6.065	0.5054	28.891	0.2006	.....	.....	.....	.....	0.20060	0.01672	1.003

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H. & V.'s REFERENCE DATA—171

UNIT VOLUME CAPACITIES AND DIMENSIONS OF STANDARD PIPE AND TUBING

Table 1 on the opposite side of this sheet gives the inside diameters and areas of standard weight iron pipes and of Type L copper tubes usually encountered in heating and air conditioning work, together with the volume of any substance flowing through them at various unit rates of flow. Now that both iron pipe and tubes are so commonly used with each carrying the same so-called *nominal* size it is frequently important to know the carrying capacity of a size of tubing compared with the similar nominal size of piping. The table makes the capacities and dimensions available at a glance and since they are placed side by side in the same table comparisons of dimensions and flow rates are apparent at once. Similar tables giving somewhat like information on standard piping and tubing frequently do not give the cross-sectional areas in square feet and neither do they give the volume of flow in terms of cu. ft. per min. Giving the volumes in cu. ft. per min. makes it possible to immediately get the weight of any particular substance flowing through the pipe by merely multiplying by the specific volume of the substance flowing.

Attention is called to HEATING & VENTILATING's Reference Data No. 47-48, 49-50, 51-52, where dimensional data are given covering standard pipe and pipe fittings; also to Reference Data No. 115-116, and 117-118 on Sizing Refrigeration Piping for Air Conditioning. Table 1 can be used to supplement the information given in these several data sheets.

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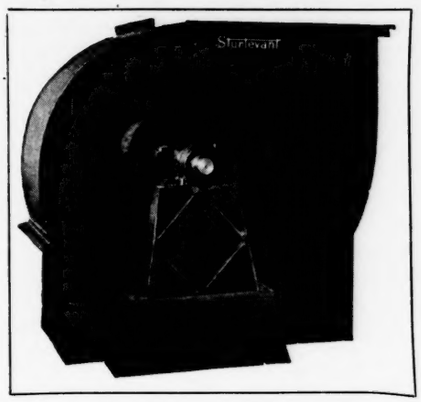
NEW EQUIPMENT



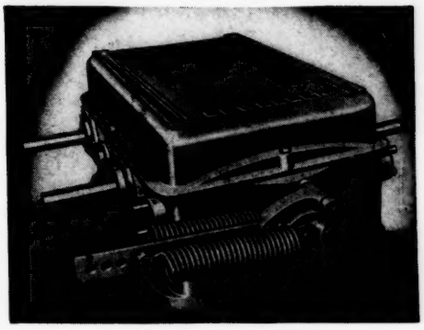
Reduced power consumption.

Sturtevant Fan

NAME AND MODEL NO.—Sturtevant Silentvane design 7 fan.
PURPOSE—For air moving in heating, ventilating and industrial applications.
FEATURES—Outstanding features are said to be: Slow rotative and peripheral speeds; quiet operation—resulting from streamline inlets; high efficiency; self-limiting horsepower characteristic with gradually increasing horsepower and volume until the point of maximum efficiency is reached, then decreasing horsepower for larger volumes; freedom from dust loading in rotors or fouling when handling dirty gas or air due to the use of straight fan blades pitched at an angle of 45° at delivery. Fan is available in all standard discharges, single and double width, single and double inlet with wheel diameters ranging from 14⅝ in. to 87 in., static pressures to 16 in. water gauge.
LITERATURE AVAILABLE—Bulletin 451.
MADE BY—*B. F. Sturtevant Company, Inc., Hyde Park, Boston, Mass.*

Lewellen Stoker Control

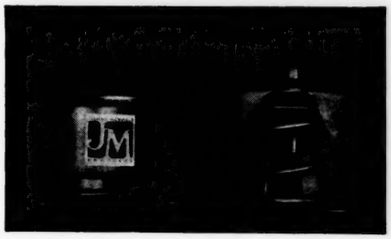
NAME—Lewellen stoker transmission and control.
PURPOSE—For regulating stoker speeds to maintain boiler pressure settings automatically.



Controls stoker speeds from boiler pressure.

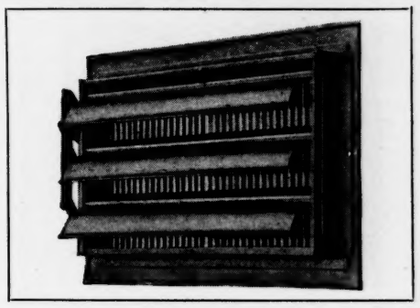
FEATURES—This transmission and control system consists of a master regulator and a variable speed stoker transmission. The master regulator is connected to the boiler and is set to maintain a given steam pressure. Whenever the steam pressure changes, the master regulator changes the speed of the stoker transmission so as to bring the steam pressure back to the proper point. A change in boiler pressure as small as ¼ lb. is said to be sufficient to cause the control to operate. In addition to changing the stoker speed, the control also operates the boiler and air supply dampers so that the air supply and draft are set to provide the proper conditions for the new fuel feed. Whenever the control lever moves suddenly, the transmission speed is changed gradually by the action of springs to the position corresponding to the position of the control.
SIZES AVAILABLE—1 to 20 hp. Normal maximum limit 10 hp.
MADE BY—*Lewellen Mfg. Co., 1095 East 10th St., Columbus, Indiana.*

Johns-Manville Vibration Isolator



For vibration control.

NAME—J-M controlled spring isolator.
PURPOSE—For isolating vibration from motors, generators, pumps, ventilating fans and similar equipment.
FEATURES—The working parts of this unit consists of a coil spring and rubber load pad which support the equipment and isolate vibration and an adjustable snubber inside the base which controls excessive motion. It is said that this isolator will take care of horizontal and torsional as well as vertical vibration and the manufacturer states that it is particularly efficient for low frequency vibrations. Loaded overall dimensions are 6 x 6 in. by approximately 3¾ in. high. Isolator is inclosed in a metal jacket designed to protect the rubber coils from oil and light.
SIZES—Two sizes: light duty for loads from 60 to 190 lb. per isolator and heavy duty for loads from 250 to 720 lb. per isolator.
MADE BY—*Johns-Manville, 22 East 40th Street, New York, N. Y.*



Double directional air control.

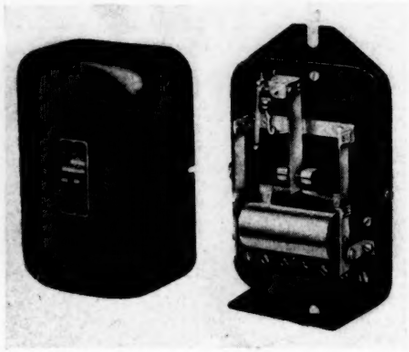
Auer Register

NAME—Airo-Flex register.
PURPOSE—For use with air conditioning systems.
FEATURES—This register features double directional control through adjustment of both grille face and back blades. It is built to permit sufficient adjustment of grille bars at time of installation for any combination of single air flow, straight, right or left. Upward and downward current is controlled by lever which regulates the new design Multi-Plane louvre for any desired directional flow, upward, straight or as much as 22½° downward. Register is furnished in the usual types for wall and baseboard.
MADE BY—*Auer Register Company, 3608 Payne Ave., Cleveland, Ohio.*

Engelhard Flualyzer

NAME—Englehard Flualyzer.
PURPOSE—For measuring the temperature and amount of carbon dioxide in flue gases.
FEATURES—Instrument operates on the thermal conductivity principle of gas analysis. It is claimed that analysis can be obtained within a few seconds after the instrument is set up and its accuracy is within .2 to .3 of 1% against Orsat checks. Dryer is furnished with the unit so that the gas measured is dried before passing into the instrument.
MADE BY—*Charles Engelhard, Inc., 90 Chestnut St., Newark, N. J.*

For measuring CO_2 and temperature.



A balanced type relay for AC or DC circuits.

Barber-Colman Relay

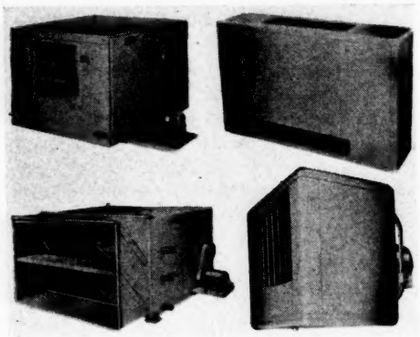
NAME—Polarized Microrelay.
PURPOSE—For many uses including: (1) for positioning motor-operated devices from either manually or automatically positioned potentiometers in self-balancing bridge circuits, (2) a voltage or current sensitive relay and (3) a conventional relay to protect delicate contacts in other circuits.
FEATURES—Four coils contained in the solenoid cylinder govern the movement of the tongue between the contacts. An armature is suspended horizontally in the axial center of this cylinder and when it is affected by a magnetic pull at either end of the cylinder because of an unbalanced condition in the bridge circuit, this motion is transmitted to the tongue causing it to move to one or the other of the contacts. This balanced solenoid action is said to permit rugged construction without affecting the sensitivity of the instrument.
MADE BY—*Barber-Colman Company, Rockford, Ill.*

Ingersoll Sun Screen

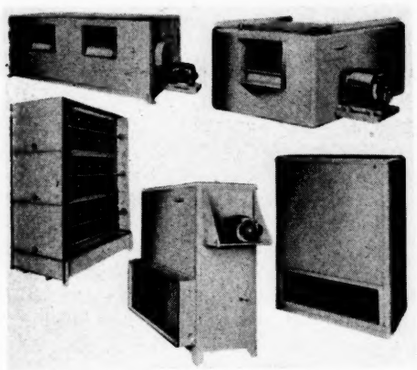
NAME—Ingersoll KoolShade screen.
PURPOSE — For reducing solar heat transmitted through windows.
FEATURES—These screens are installed like ordinary insect screens on the outside of the window but they are said to provide protection against sun heat as well as against insects. They are made up of horizontal flat bronze strips woven together every half inch vertically with bronze wire. The strips are set horizontally at an angle of 17° with the horizon. Manufacturer claims when the sun reaches an altitude which is 40° above the horizon, the solar rays can not penetrate the screen. It is said, at the same time, one can look out clearly with as good a vision as with an insect screen. Manufacturer states that the KoolShade screens will transmit only approximately 19% of the solar heat reaching them.
MADE BY—*Ingersoll Steel & Disc Division, Borg-Warner Corporation, 310 South Michigan Ave., Chicago, Ill.*

Trane Climate Changers

NAME—Trane Climate Changers.
PURPOSE—For conditioning of air.
FEATURES—This line has been redesigned and revised to incorporate the latest developments in the air conditioning field and to include all of the Trane unit coolers and air conditioners under the single designation of Trane Climate Changers. The line is made up of 5 individual type units. Type D includes a group of air conditioners for a wide variety of applications. Sizes range from small horizontal and vertical models for hotel and office application to large commercial units capable of delivering a maximum of 20,000 c.f.m. Type A units have been designed expressly for apartment house applications—for individual apartment air conditioning. They are available in both vertical and horizontal models and may be placed in a closet or any out of the way spot or furred into the ceiling. The type F climate changer is a floor type unit and provides year-round air conditioning for home or office. It occupies a minimum of floor space and is furnished in a neutral color which blends with any interior. Type M is designed especially for installation where economy is the deciding factor in a selection of equipment. All of the essential features of complete air conditioning are incorporated in this unit so that quality air control can be obtained at lowest possible cost. It is available in both vertical and horizontal models. The type X climate changer is a propeller type comfort cooler recommended for spot cooling. Also announced at this time is a Trane sprayed coil unit designed especially for a built-up system requiring a separate fan motor, drive and filters. Because its coils are sprayed, this unit provides air washing in winter or summer. During the heating cycle, either steam or hot water may be used with humidification obtained by means of washer type spray nozzles. During the summer, cold water, brine or direct expansion refrigerants may be used for cooling.
CAPACITIES—Type D, up to 20,000 c.f.m. Type A, 300 to 1600 c.f.m. Type F, 250 to 1500 c.f.m. Type M, 1200 to 12,500 c.f.m. and Type X, 530 to 2250 c.f.m. Sprayed coil unit type, 2000 to 48,000 c.f.m.
MADE BY—*The Trane Company, La Crosse, Wisconsin.*



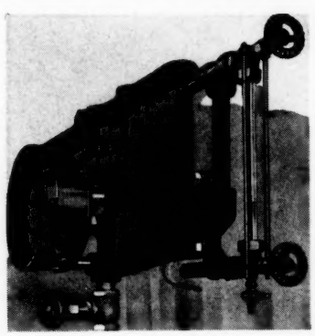
Trane Climate Changers. Upper line (L to R) horizontal model A, floor type model F. Lower line (L to R) horizontal type M and spot cooler type X.



Upper line (L to R) Type D Climate Changers, large and small horizontal types. Lower line (L to R) sprayed coil unit, type D medium vertical unit and type D small vertical unit.

Mercoid Boiler Control

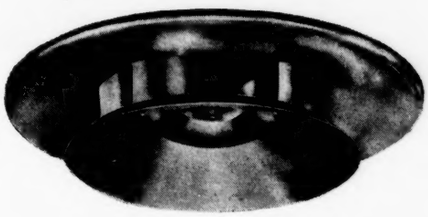
NAME AND MODEL NO.—Combination pressure and low water control, type DA-131Q.
PURPOSE—For protection of low pressure, automatically-fired steam boilers against the hazards of firing into a dry boiler or building up excess pressure.
FEATURES—Control complies with the ASME Code and is furnished with quick hook-up attachments for simplified installation. Unit is said to be light in weight and of packless construction. Double outside adjustments are provided for setting the pressure range and in setting the control it is merely necessary to turn the adjustments until pointers on a calibrated dial indicate the operating pressures desired. Unit is equipped with Mercoid switch. Range adjustable from 0 to 10 lb. Electric capacity 10 amp. at 115 volts, 5 amp. at 230 volts.
MADE BY—*The Mercoid Corporation, 4201 Belmont Ave., Chicago, Ill.*



For protecting boilers against lack of water or high pressure.

Demuth Air Distributor

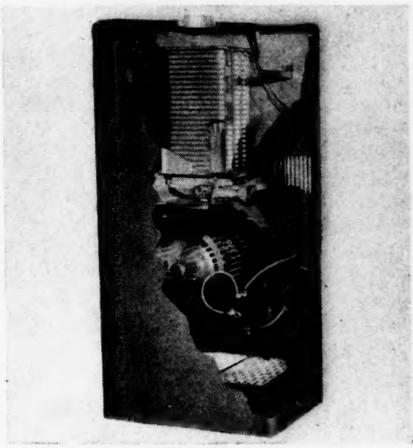
NAME—Demuth air distributor.
PURPOSE—For introducing conditioned air into rooms without drafts.
FEATURES—Distributor consists of a ceiling flange and two deflecting cones. The ceiling flange is slipped into the duct connection and the first deflecting cone is mounted co-axially and spaced from the flange thereby forming an emitting nozzle. Within this nozzle opening are placed curved deflecting vanes. The second deflecting cone extends beyond the edge of the principal cone and is spaced away from the principal cone to form a tangential injector nozzle. The manufacturer states that the air distributor accomplishes three actions necessary to the balanced distribution of air. These three actions are stated to be (1) a circulatory motion which evenly distributes the conditioned air throughout the room, (2) a vortex, forming in the room directly below the device, draws the air of the room to the distributor, (3) an injector principle, providing a recirculation of the room air with the conditioned air. It is further stated that this distributor introduces air to the room at approximately a 10 to 15° angle from the ceiling in a circulatory path which is caused by the deflecting cone and the series of curved vanes. Distributor is installed by fastening the ceiling flange to the duct by means of steel screws and then using a single nut to hold the deflecting cones. Unit is available with or without lighting fixture.
SIZES AND CAPACITIES—Six sizes with neck diameter from 6 to 24 in. and capacities from 80 to 15,000 c.f.m.
MADE BY—*Charles Demuth & Sons. Jamaica, N. Y.*



For draftless air distribution.

Surface Combustion Air Conditioners

NAME—Janitrol air conditioners.
PURPOSE—For winter air conditioning using gas as a fuel.
FEATURES—This new line of gas fired winter air conditioners features such devices as the Amplifire burner and the Multi-Thermex heat exchanger. The Amplifire burner is similar to one which has been widely used by this company in its industrial applications and is said to represent a marked advance in the elimination of any tendency to "on" and "off" noise. The Multi-Thermex heat exchanger consists of a battery of cast-iron Thermex tubes. Integrally cast heat absorption fins are staggered vertically inside each Thermex tube while on the outside are integrally cast convectors. The most generally used sizes of these winter air conditioners are the 60,000 and 90,000 B.t.u. capacity units which are shipped completely assembled. This feature makes it possible for the factory to make complete tests and final inspection of the unit in actual operation before it is crated.
MADE BY—*Surface Combustion Corporation, Toledo, Ohio.*



For complete winter air conditioning.

Pan American Solar Water Heater

NAME—Pan American Solar heater.
PURPOSE—For heating service hot water using solar energy.
FEATURES—This service hot water system consists of a solar heat absorbing unit and an insulated storage tank. The solar heating unit is made up of flat drawn copper tubing mounted on a corrugated copper backing. Between this backing and the bottom of the enclosing box is an insulated area made up of Reynolds Metallation and two air spaces. This whole unit is housed in a metal box with a double glazed window in the top. The heated water from the coil in the box goes to an insulated horizontal tank where it is stored until needed. Manufacturer states that this heater is guaranteed not to freeze.
MADE BY—*The Pan American Solar Heater, Inc., 2730 N.W. 2nd Ave., Miami, Fla.*

Domestic hot water from the sun.

Torrington Fan Blades

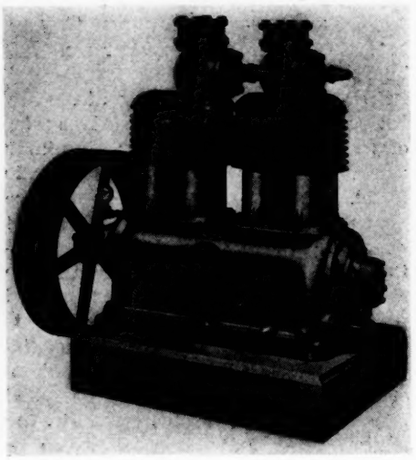
NAME—Airistocrat propeller fan blades.
PURPOSE—For circulating air.
FEATURES—A completely new series of three blade fans for air circulator work. Blades were previously made in 20, 24 and 30 in. diameter but are now made in 10, 12, 14, 16, 18, 20, 24 and 30 inch sizes. By slightly increasing the blade pitch on these fans the manufacturer claims to have obtained performance in free air which is equivalent to the performance of its 4-blade Airistocrat fans of equal diameters. While these fans are designed primarily for operation in free air, the manufacturer states that they can be used for light pressure work such as evaporative coolers. Blades are insulated from the mounting spiders which is said to result in smooth and quiet operation. They are offered in the same standard finishes as Airistocrat 4-blade fans.
MADE BY—*Torrington Manufacturing Company, Torrington, Conn.*

Airistocrat quiet propeller fan blades.

Nelson Insulation

NAME—Nelson Masterfil insulation.
PURPOSE—For the insulation of building walls and ceilings.
FEATURES—Masterfil is expanded Vermiculite which is an alteration product of biotite mica and composed chiefly of aluminum magnesium silicate. When heated to 1400 to 1600F Vermiculite expands, increasing its volume about 12 times. The expansion process produces dead air cells which is said to give the material high insulating properties. Manufacturer states that this product is chemically inert, has a fusion point of 2462F, can always be installed at the same density and therefore will deliver the efficiency claimed, and because of its granular structure, it will not retain moisture.

Masterfil is stated to have a K factor of .31 B.t.u. per hour per degree temperature difference per inch of thickness at 70F.
MADE BY—*The B. F. Nelson Mfg. Co., Minneapolis, Minn.*



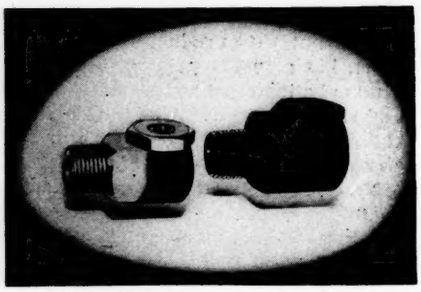
Equipped with roller bearings.

Baker Freon Compressor

NAME AND MODEL NUMBER—Baker Freon Compressor, Model F 15BA.
PURPOSE — For compressing Freon refrigerant.
FEATURES—Semi-steel cylinders are precision bored and hone finished with cooling fin cast integral. Double trunk type pistons are semi-steel, full skirt, precision ground. Five rings per piston are provided including one oil wiping ring. Multiple anti-friction roller bearings of heavy duty type are provided on both the drive end and the blind end of the main bearing. The crankshaft seal is of a balanced bellows type. Crankshaft main connecting rod bearings and piston pins are under full pressure lubrication from built-in, positive drive, large capacity, high pressure, gear type oil pumps. Discharge valves are of full opening, multiple disc type made of stainless steel while the suction valves are of the large area, low lift spring type. The drive is of the multiple V-belt type.
MADE BY—*Baker Ice Machine Company, Inc., 1529 Evans St., Omaha. Nebraska.*

Spraying Systems Nozzle

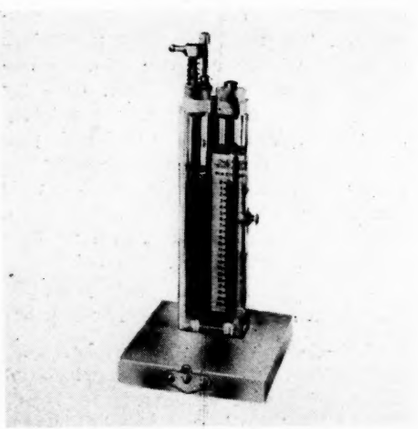
NAME—Flat Spray nozzle.
PURPOSE—For use in applications requiring a flat spray with heavy center.
FEATURES—Nozzles are for metal cleaning and processing, industrial washing machines, or for air conditioning applications. Spray is of the flat type with slightly heavy center and can be had in a number of different spray angles. Standard stock construction is of brass or iron, although other materials can be specified.
SIZES AND CAPACITIES—¼-in. male pipe connection with capacities of 0.5 to 3.5 gal. per min. at 10 lb. pressure and 3 to 7 gal. per min. at 40 lb. pressure.
MADE BY—*Spraying Systems Co., 4021 W. Lake St., Chicago, Ill.*



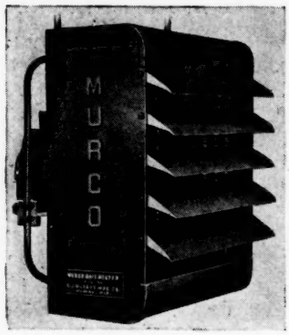
For spraying corrosive fluids.

Dwyer CO_2 Indicators

NAME AND MODEL NO.—Pocket CO_2 indicator, model 800.
PURPOSE—For indicating the amount of carbon dioxide in flue gases.
FEATURES—Unit is said to be compact in size and high in efficiency. The body of the instrument is made of crystal clear plastic material which is said to be unaffected by the absorbent solution used in the indicator. No glass is used and all passages are drilled and reamed in a solid block of the clear plastic. All metal parts that come in contact with the chemical solution are said to be stainless steel. Manufacturer states that the solution can not be spilled as the plunger and vent close automatically. Unit is furnished with a carrying case with a built-in compartment for the addition of a draft gage and flue gas thermometer. The complete unit is said to weigh 4 lb. and is furnished with all accessories. rubber tubing, aspirator bulb, terminal tube and operating instructions.
OPERATION—The gas sample to be tested is pumped into the indicator with a dozen strokes of the aspirator bulb while the plunger is held down. The absorbing unit is raised and lowered and the percentage of CO_2 is indicated immediately.
MADE BY—*F. W. Dwyer Manufacturing Co., 565 W. Washington Boulevard. Chicago. Ill.*



For rapid determination of CO_2



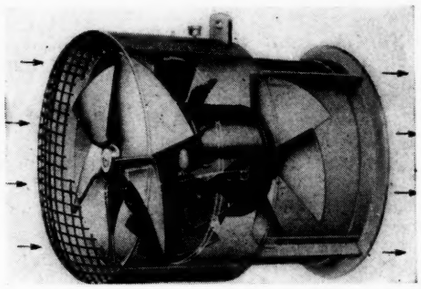
Capacities up to 556,000 B.t.u. per hour.

Murray Unit Heater

NAME—Murco unit heater.
PURPOSE—For supplying warm air using steam as a source of heat.
FEATURES—The heating elements in these unit heaters are constructed of copper tubes that are expanded into alloy cast- iron headers. The condenser is attached to the casing by a special spring support device so that the condenser is full floating to overcome contraction and expansion.
SIZES AND CAPACITIES—Twenty-five models with capacities ranging from 20,600 to 556,000 B.t.u. per hr. with air delivery of 430 to 8600 c.f.m.
MADE BY—*D. J. Murray Mfg. Co. Wausau, Wis.*

Wing Forced Draft Blower

NAME AND MODEL NO.—Wing forced draft blower, type COM.
PURPOSE—A forced type blower for supplying air at static pressures as high as 10 in. water.
FEATURES — Blower is of the axial flow type and is a two-stage unit. It consists of a constant speed, fully enclosed, dust proof motor with double extended shaft and an axial flow fan wheel mounted on each extension. Built-in adjustable damper mechanism placed between the two fan stages is said to effect a precise capacity regulation with decrease in horsepower over a wide range.
CAPACITIES — For capacities up to 50,000 c.f.m. at static pressures as high as 10 in.
MADE BY—*L. J. Wing Mfg. Co.*, 154 *West 14th St., New York, N. Y.*



For static pressures up to 10 inches.

BADGER EXPANSION JOINTS

Can you afford to do this?

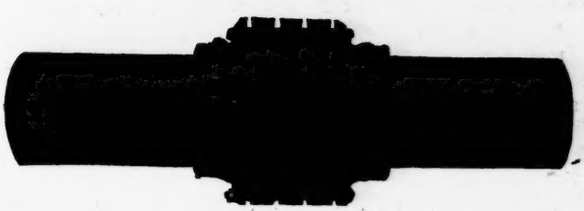
1 **Pass up the Proved Superiority of the Directed Flexing Design?**

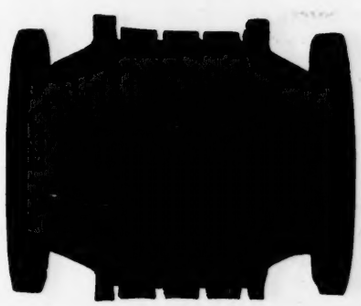
2 **Ignore the Thorough Heat Treatment given these Joints Throughout Fabrication?**

3 **Discount the Experience Back of Them?**

Engineers of E. B. Badger & Sons Co. have spent more than forty years manufacturing expansion joints of the corrugated, packless type. They pioneered this type of joint, developed it, and brought out many improvements, the most recent being these three: Directed Flexing, Scientifically Controlled Heat Treatment, and Stainless Steel.

Careful buyers like to deal with those who are leaders in their respective industries.

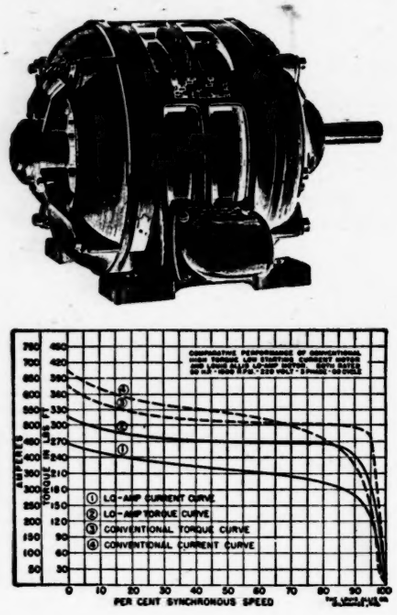




E. B. BADGER & SONS CO.

75 PITTS STREET, BOSTON, MASS.

Agents in Principal Cities


① LO-AMP CURRENT CURVE
② LO-AMP TORQUE CURVE
③ CONVENTIONAL TORQUE CURVE
④ CONVENTIONAL CURRENT CURVE
PER CENT SYNCHRONOUS SPEED

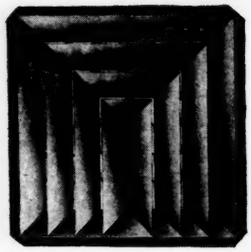
Louis Allis Lo-Amp motor.

Allis Electric Motor

NAME—Lo-Amp electric motor.
PURPOSE — Specially designed for driving refrigerating and air conditioning equipment.
FEATURES—Manufacturer states that the inherent ruggedness, simplicity, high starting torque and low locked rotor current of this new motor make it perfectly adapted for refrigerating and air conditioning applications. Motor does not have any centrifugal switches, relays, brushes or slip rings and does not require special controls to operate. Curves 1 and 2 show the inrush current and starting torque of this motor as compared to curves 3 and 4, which show corresponding data on a standard double deck squirrel cage motor. Motors can be supplied with either high torque or normal starting torque.
MADE BY—*The Louis Allis Co., Milwaukee, Wis.*

Air Devices Air Diffuser

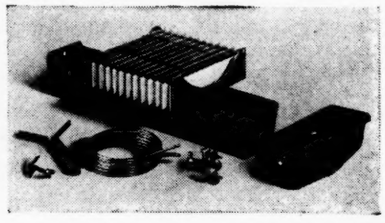
NAME—Agitair, type R diffuser.
PURPOSE—For introducing conditioned air into rooms without drafts.
FEATURES—Diffuser can be employed for either ceiling, sidewall or baseboard air delivery. It is said to be particularly suitable for those applications which require unequal air distribution without drafts, as for example in an off-center ceiling location. To take care of all such applications, the unit can be constructed to give either one, two-way, three-way, or four-way diffusion. One-way diffusers are made up of louvers running parallel to the side of the diffuser and at an angle of approximately 30° with the ceiling or wall to which the frame is attached. Between these louvers are small vanes inserted obliquely and designed to cause the air to leave the diffuser at an angle of 22½° or less with the wall or ceiling. The manufacturer states that a discharge angle of 22½° or less is desirable since it causes the air stream to follow the ceiling or wall. It is further stated that this construction of louvers and vanes is employed in place of simple vanes at 22½° in order to increase the free area through the outlet and thus decrease the size of the diffuser. The small vanes are also said to greatly increase the turbulence of the discharged air which results in a quick mixing of the conditioned air and room air and thus gives rapid temperature equalization. Two, three, four-way diffusers are constructed similarly but have vanes which discharge air in two, three or four directions.
MADE BY—*Air Devices—Incorporated, 17 East 42nd St., New York, N. Y.*



Agitair type R three-way air diffuser.

Viking Humidifier

NAME—Viking humidifier, series 1100.
PURPOSE—For installation in warm air heating systems for adding moisture to air.

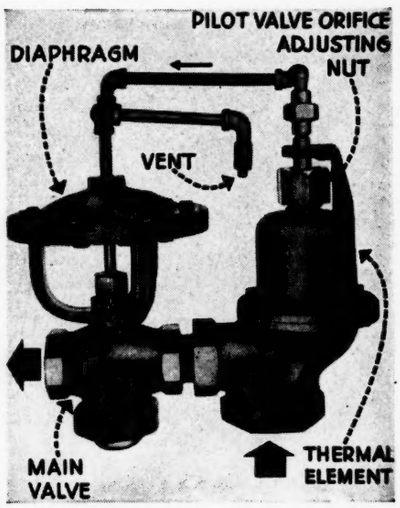


For adding moisture to air.

FEATURES—Humidifier consists of two separate units—an evaporating pan and a float chamber which contains the Viking Top-seat float valve assembly. Float tank is located outside the furnace so that all the working parts are accessible and free from heat, mineral deposits and corrosion. The evaporating pan is protected by two coats of acid resisting porcelain enamel and can be installed in either a warm air plenum chamber or ducts. Twelve Pyroxene evaporator plates are suspended from a copper rack to provide an evaporating surface of 480 square inches.
MADE BY—*Viking Air Conditioning Corporation, 9500 Richmond Ave., S.E., Cleveland, Ohio.*

Armstrong Air Eliminators

NAME—Air eliminators.
PURPOSE—For the removal of air from steam equipment.
FEATURES—Unit consists of a conventional type of diaphragm valve, to which has been added a special dome shaped inlet chamber. Housed in the dome of the inlet chamber is a bellows type thermal expansion unit which is designed to raise and lower a needle valve that seats against an orifice mounted in the top of the dome. This valve acts as a pilot valve to admit pressure to the top of the diaphragm. The other pipe above the diaphragm is fitted with a small relief vent which dissipates the pressure above the diaphragm when the pilot valve is closed. Operation is automatic and is based on the fact that air in a steam system has the effect of lowering the steam pressure and hence its temperature. When the air and steam mixture enters the valve, it closes the thermal unit which contracts and opens the needle valve. This, in turn, applies pressure to the diaphragm, which is depressed, thus opening the main valve and permitting the steam-air mixture to escape. When the air has been exhausted, steam expands the thermal element causing it to close the needle valve. With pressure relieved above the diaphragm, internal pressure forces the main valve to close. The sensitivity of the main valve can be adjusted by means of a regulating nut. Unit is said to be self-compensating for changes in steam pressure. Unit measures 12½ in. in height and weighs 30 lb.
MADE BY—*Armstrong Machine Works, 846 Maple St., Three Rivers, Mich.*



For automatic venting of air.

all three

GIVE YOU GOOD AIR CONDITIONING.

LESS THAN ALL THREE GIVE YOU—?

★ ADEQUATE CONTROL
a Complete Control System, Coordinated to Produce the Desired Results, either Electric, Pneumatic or a Combination of Both, as the Job Demands

WHEN you take all three factors into consideration, you have complete assurance that your air conditioning or space heating installation will function as it should. But if one or more are slighted, the result may be highly unsatisfactory.

The finest engineering and mechanical equipment will fail to produce the desired results unless the system is adequately controlled. Minneapolis-Honeywell, the only manufacturer of a complete line of both electric and pneumatic controls, will meet the individual requirements of any job, old or new, large or small. A Minneapolis-Honeywell representative is available for consultation without cost or obligation.

Minneapolis-Honeywell Regulator Co., 2715 Fourth Ave. S., Minneapolis, Minn. Canadian Plant: Toronto, Ont. European Plant: London. Company owned branches in 49 other cities.

MINNEAPOLIS-HONEYWELL *Control* SYSTEMS

THE MODUTROL SYSTEM OF ELECTRIC CONTROL
THE GRADUTROL SYSTEM OF PNEUMATIC CONTROL
BROWN INSTRUMENTS FOR INDICATING AND RECORDING

Degree-Day Figures for February, 1940

HEATING & VENTILATING continues its twelfth year of publishing degree-day data for various large cities

	Albany, N. Y.	Atlanta, Ga.	Baltimore, Md.	Birmingham, Ala.	Boston, Mass.	Buffalo, N. Y.	Burlington, Vt.
Degree-days for February, 1940	1248	663	798	611	1029	1163	1387
Degree-days, Sept. 1, '39 to Feb. 29, '40	5533	2877	3526	2668	4481	4985	6100
Degree-days, Sept. 1, '38 to Feb. 28, '39	4945	2079	2954	1831	3999	4499	5544
Degree-days, Sept. 1, to Feb. 28, Normal	4868	2370	3462	2023	4322	4768	5496

	Cheyenne, Wyo.	Chicago, Ill.	Cincinnati, Ohio	Cleveland, Ohio	Columbus, Ohio	Denver, Colo.	Des Moines, Iowa
Degree-days for February, 1940	1045	1038	928	1058	964	853	1152
Degree-days, Sept. 1, '39 to Feb. 29, '40	4906	4557	4139	4445	4330	3885	4923
Degree-days, Sept. 1, '38 to Feb. 28, '39	5224	4174	3378	3838	3634	4223	4446
Degree-days, Sept. 1, to Feb. 28, Normal	5179	4582	3666	4441	4113	4273	4935

	Detroit, Mich.	Dodge City, Kan.	Duluth, Minn.	El Paso, Tex.	Erie, Pa.	Evansville, Ind.	Fort Wayne, Ind.
Degree-days for February, 1940	1110	858	1346	420	1102	858	1057
Degree-days, Sept. 1, '39 to Feb. 29, '40	4816	3999	6127	2076	4635	3859	4796
Degree-days, Sept. 1, '38 to Feb. 28, '39	4434	3584	6568	2199	4060	3010	4146
Degree-days, Sept. 1, to Feb. 28, Normal	4718	3958	6634	2101	4434	3348	4503

	Fort Worth, Tex.	Grand Rapids, Mich.	Green Bay, Wis.	Harrisburg, Pa.	Hartford, Conn.	Indianapolis, Ind.	Ithaca, N. Y.
Degree-days for February, 1940	506	1098	1230	950	1080	950	1154
Degree-days, Sept. 1, '39 to Feb. 29, '40	2192	4707	5361	4210	4751	4307	5093
Degree-days, Sept. 1, '38 to Feb. 28, '39	1884	4341	5272	3750	4145	3616	4591
Degree-days, Sept. 1, to Feb. 28, Normal	1904	4863	5778	4077	4416	4099	4851

	Kansas City, Mo.	Knoxville, Tenn.	La Crosse, Wis.	Lansing, Mich.	Lincoln, Neb.	Little Rock, Ark.	Los Angeles, Calif.
Degree-days for February, 1940	937	719	1188	1171	1130	652	167
Degree-days, Sept. 1, '39 to Feb. 29, '40	4210	3278	5306	5080	4773	2888	451
Degree-days, Sept. 1, '38 to Feb. 28, '39	3489	2572	5170	4720	4091	2292	820
Degree-days, Sept. 1, to Feb. 28, Normal	3861	2964	5578	5202	4643	2380	1016

	Louisville, Ky.	Madison, Wis.	Memphis, Tenn.	Milwaukee, Wis.	Minneapolis, Minn.	Nashville, Tenn.	New Haven, Conn.
Degree-days for February, 1940	861	1223	686	1088	1326	733	988
Degree-days, Sept. 1, '39 to Feb. 29, '40	3873	5230	3008	4784	5807	3319	4402
Degree-days, Sept. 1, '38 to Feb. 28, '39	3055	4989	2232	4604	5798	2532	3881
Degree-days, Sept. 1, to Feb. 28, Normal	3327	5557	2470	5185	5950	2850	4230

	New Orleans, La.	New York, N. Y.	Norfolk, Va.	Oklahoma, City, Okla.	Omaha, Neb.	Peoria, Ill.	Philadelphia, Pa.
Degree-days for February, 1940	338	930	657	709	1162	1030	877
Degree-days, Sept. 1, '39 to Feb. 29, '40	1427	4027	2924	3096	4956	4666	3821
Degree-days, Sept. 1, '38 to Feb. 28, '39	884	3446	2129	2702	4330	4109	3251
Degree-days, Sept. 1, to Feb. 28, Normal	965	3869	2583	2986	4765	4673	3629

	Pittsburgh, Pa.	Portland, Me.	Portland, Oreg.	Providence, R. I.	Reading, Pa.	Reno, Nev.	Richmond, Va.
Degree-days for February, 1940	950	1101	515	1010	927	713	726
Degree-days, Sept. 1, '39 to Feb. 29, '40	4193	5116	2579	4476	4095	3387	3402
Degree-days, Sept. 1, '38 to Feb. 28, '39	3536	4720	2862	3937	3570	3979	2630
Degree-days, Sept. 1, to Feb. 28, Normal	3947	4985	3174	4316	4082	4149	2935

	Rochester, N. Y.	St. Louis, Mo.	Salt Lake City, Utah	San Francisco, Calif.	Scranton, Pa.	Seattle, Wash.	Spokane, Wash.
Degree-days for February, 1940	1170	899	746	280	1068	525	845
Degree-days, Sept. 1, '39 to Feb. 29, '40	4991	3959	3552	1336	4808	2562	4163
Degree-days, Sept. 1, '38 to Feb. 28, '39	4488	3169	4239	1637	4235	2925	4355
Degree-days, Sept. 1, to Feb. 28, Normal	4825	3652	4144	1770	4552	3308	4707

	Springfield, Ill.	Syracuse, N. Y.	Toledo, Ohio	Trenton, N. J.	Utica, N. Y.	Washington, D. C.	Wichita, Kan.
Degree-days for February, 1940	985	1179	169	932	1295	811	875
Degree-days, Sept. 1, '39 to Feb. 29, '40	4358	5121	3775	4149	5592	3667	3883
Degree-days, Sept. 1, '38 to Feb. 28, '39	3689	4503	4181	3573	4965	3033	3333
Degree-days, Sept. 1, to Feb. 28, Normal	4191	4980	4467	3715	4966	3559	3773

Methods of applying the degree-day in connection with the operation of heating plants or for the prediction of fuel consumption of heating plants are described fully in the new enlarged edition of the DEGREE-DAY HANDBOOK, published by HEATING & VENTILATING, 148 Lafayette Street, New York, price $3. Degree-days as given above for a "normal" month or season are based on averages for a long period of years, ending about 1922. Averages covering different periods will disagree with the above figures slightly.

Now in 3, 5, 7½, 10 and 15 Ton Capacities

CURTIS Packaged Air Conditioners

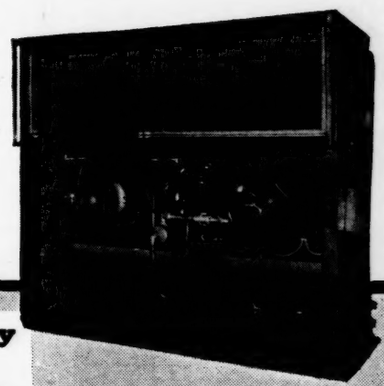
Meet ALL Requirements

● With a wide range of from 3 to 15 tons capacity, Curtis Packaged Air Conditioners now meet the demands of a variety of markets with complete mechanically refrigerated air conditioning at low cost.

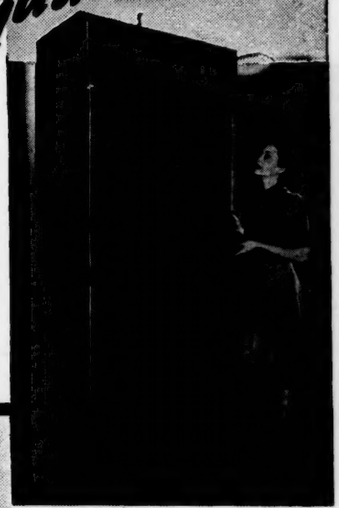
Every type of retail establishment is now a prospect for this Curtis equipment, for they can profit from the advantages of air conditioning without costly installation charges or disturbance to fixtures.

The Curtis Store and Office Cooler and the Curtis Remote or Central Type Air Conditioner are completely factory designed and built packaged units that cool, dehumidify, circulate and filter the air. They are quickly and easily installed, readily financed, and are adaptable for heating if desired.

The demand for Curtis Packaged Air Conditioning is growing every day. Write to Curtis for complete information on the Curtis line.



7½, 10, 15-ton Remote or Central Type Air Conditioner



3 and 5-ton Packaged Type Air Conditioner

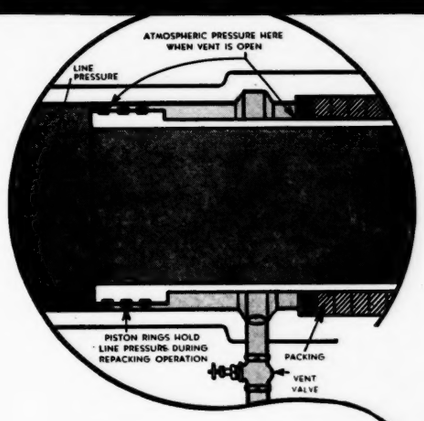
Curtis Refrigerating Machine Company

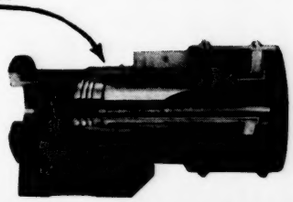
Division of
Curtis Manufacturing Co.
1999 Kienlen Ave. St. Louis, Mo.
Established 1854

CURTIS REFRIGERATION AIR CONDITIONING ... COMMERCIAL

ADSCO PISTON-RING EXPANSION JOINT

Can be REPACKED UNDER PRESSURE without Service Interruption


ATMOSPHERIC PRESSURE HERE WHEN VENT IS OPEN
LINE PRESSURE
PISTON RINGS HOLD LINE PRESSURE DURING REPACKING OPERATION
PACKING
VENT VALVE



Piston rings hold the line pressure when the vent chamber is opened to atmosphere, thereby relieving the stuffing box of all pressure, permitting the complete removal of all packing without shutting off steam.

The ONLY Slip Type Joint which Can be UNPACKED UNDER PRESSURE

This exclusive piston ring feature enables you to remove ALL the packing and insert a complete set of NEW packing rings without interruption to service when infrequently necessary to repack this joint.

This is but the latest of many ADSCO improvements in slip type expansion joints during the past 60 years.

Equally important for dependable joint operation are these ADSCO features—correctly proportioned stuffing boxes; polished slips of time-tested material for ease of movement; positive limit stops prevent overtravel of slip; practical internal and external guides for proper alignment and pressure fittings for replacing lubricant in the packing thereby keeping it pliable and prolonging its life.

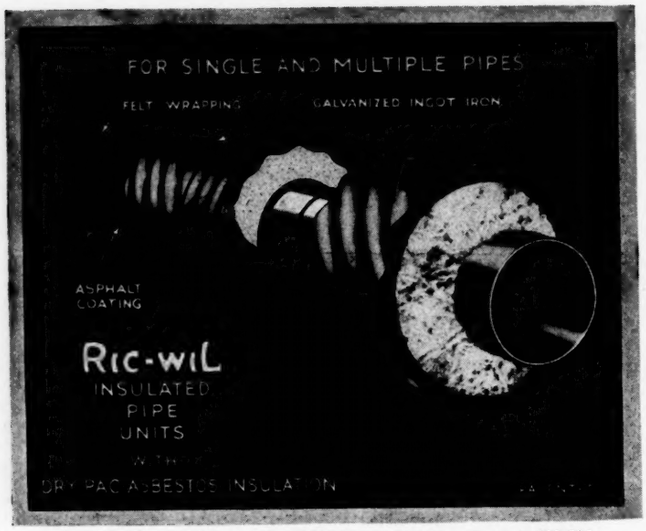
You get all of these features in ADSCO Slip Type Expansion Joints at no price premium over comparable types of joints.

Write for ADSCO Catalog No. 35V.

AMERICAN DISTRICT STEAM COMPANY

NORTH TONAWANDA, N.Y.

IN BUSINESS OVER SIXTY YEARS



U. S. Patents 1,991,455 and 2,050,968. Canadian Patent 360,816. Other Patents Pending

RIC-WIL Insulated PIPE UNITS

PRE-SEALED UNITS for underground steam lines, in standard pipe lengths, complete with steam pipes and all accessories.

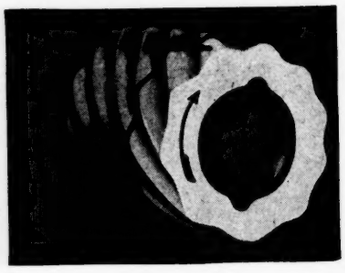
ARMCO HEL-COR CONDUIT AND FITTINGS of heavy gauge pure ingot iron, heavily galvanized, with protective asphalt coating and asbestos-asphalt felt wrapping to resist all forms of deterioration.

WATER-TIGHT, light in weight, yet amply strong to stand abnormal stress and strain, even in shallow trenches.

INSULATION — any standard material in recommended thickness may be specified, such as 85% magnesia or laminated asbestos spongefelt sectional coverings. Asbestos fibre, hand moulded insulation with roofing jacket, can also be furnished.

COUPLINGS which connect units are positive and subject to complete inspection at all times. No guess work involved.

PIPE SUPPORT GUIDES (semi-steel rings carried in special cement insulation) are threaded into each end of the Hel-Cor Conduit, to give permanent pipe alignment, and seal ends of units. These supports are locked securely in place but may be unscrewed (see illustration).



A correctly engineered system built by manufacturers of 30 years' standing, Ric-wiL Insulated Pipe Units are the culmination of experience gained in the production of over 700 miles of underground steam lines. New complete Catalog No. 40, describing all Ric-wiL Systems, sent on request.

The RIC-WIL Co., Union Commerce Bldg., Cleveland, Ohio

New York **San Francisco** **Chicago**

Agents in principal cities

REGISTERED IN U. S. PATENT OFFICE

.RIC-WIL.

CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

COMING EVENTS

APRIL 9-10. Annual Midwest Power Conference; Palmer House, Chicago, under direction of Prof. S. E. Winston, 401 S. Quincy St., Hinsdale, Ill.

APRIL 9-11. Iowa State College Heating and Air Conditioning Conference under the auspices of the Mechanical Engineering Department and Engineering Extension Service of the Iowa State College and the Iowa-Nebraska section of the American Society of Heating & Ventilating Engineers. To be held at Engineering Exhibit Hall, Campus, Iowa State College, Ames, Iowa.

APRIL 12-13. First Housing Conference sponsored by The University of Texas, Austin, Texas. Hugo Leipziger, housing consultant, of Berlin, Paris, and Australia, will assist the faculty of the Department of Architecture in conducting the conference.

APRIL 22. Fourth Annual Coal Utilization Institute of the University of Michigan and the 25th Fuel Engineering Conference of Appalachian Coals, Inc. To be held at University of Michigan, Ann Arbor, Mich.

MAY 14-17. Annual meeting of the National District Heating Association; French Lick Springs Hotel, French Lick, Indiana. Further information available from John F. Collins, Jr., Secretary-Treasurer National District Heating Association, 1231 Grant Building, Pittsburgh, Pa.

MAY 20-22. Annual convention of Association of Gas Appliance and Equipment Manufacturers, at the French Lick Springs Hotel, French Lick, Ind.

MAY 21-24. 34th annual convention of the Smoke Convention Association at Hotel Statler, St. Louis.

MAY 27-29. 51st annual convention of the Heating, Piping and Air Conditioning Contractors National Association. To be held at the Hotel Pennsylvania, New York City.

JUNE 3-5. National Warm Air Heating and Air Conditioning Association, Mid-Year Meeting, Palmer House, Chicago. Managing Director, Allen W. Williams, 5 East Long Street, Columbus, Ohio.

JUNE 4-7. The 25th annual meeting of the American Association of Industrial Physicians and Surgeons together with the first annual meeting of the American Industrial Hygiene Association; Hotel Pennsylvania, New York City.

JUNE 6-7. Stoker Manufacturers Association at Hot Springs, Va.

JUNE 9-11. Summer meeting of the American Society of Refrigerating Engineers; Skytop, Pa.

JUNE 17-19. Summer meeting American Society of Heating and Ventilating Engineers; Washington, D. C.

OCTOBER 8-11. The 69th annual meeting of the American Public Health Association, Detroit. Book-Cadillac Hotel, Headquarters.

DECEMBER 2-7. 14th National Exposition of Power & Mechanical Engineering at the Grand Central Palace, New York, N. Y. For information write National Exposition Co., Grand Central Palace, New York, N. Y.

H&V'S PHOTOS

Front Cover—The National Broadcasting Company, New York.

Pages 15-19—The Austin Company, Cleveland, Ohio.

Pages 25-27—The Harvard Film Service, Cambridge, Mass.

Page 33—C. W. Ackerman, Cleveland, for Hill & Knowlton, Cleveland, Ohio.

Pages 35-36—Hill & Knowlton, Cleveland, Ohio.

Page 37—C. W. Ackerman, Cleveland, for Hill & Knowlton, Cleveland, Ohio.

Page 38 (Upper photograph)—John Adams Davis, New York City for Hill & Knowlton, Cleveland, Ohio.

Page 38 (Lower photograph) — The Trane Company, La Crosse, Wis.

Page 40—Ducon Co., Woodside, L. I., New York.

WITH THE MANUFACTURERS

Airtemp Division, Chrysler Corp., Dayton, Ohio, announce new distributors in five important markets. Distributors are *Wholesale Lumber & Building Materials, Inc.*, 7500 E. Davison Ave., Detroit; *Kinser Supply Co.*, 1614 E. 40th St., Detroit; *L. D. McCandless & Co.*, 5124 Penn Ave., Pittsburgh; and *Ohio Metal & Manufacturing Co.*, 818 Monument Ave., Dayton. These companies will handle a complete line of heating equipment while the *Central Coal Company* of New York has been franchised to handle only oil heating equipment under the present distributor, *Marr & Futoran, Inc.*

Anemostat Corp. of America, New York, has added to its field organization as follows: *D. E. McCulley* will represent the company in Nebraska and Western Iowa, with headquarters in Omaha; *George W. Hummel* will handle the high velocity air diffuser in Phoenix, Ariz.; two additions to the organization in the Pacific Northwest are the Trane Co. at Spokane, Wash., *S. D. Brown* manager, and the *T. C. Langdon Co.* of Portland, Ore.; *Boyd Engineering Co.*, with offices in Albuquerque and El Paso, has been appointed to represent the company in New Mexico and Western Texas; *Robert C. Sweatt* of Vancouver, B. C., has been appointed to represent the company in that city.

Central Tube Company, Pittsburgh, has announced its decision to liquidate its business. Arrangements have been made for the servicing of the company's pipe stock accounts by *Spang Chalfant, Inc.*, Pittsburgh, effective February 26, 1940. Spang Chalfant will make available to the former customers of Central Tube a complete line of tubular products. The output of an additional patented process continuous weld mill, now practically completed, will increase the service facilities of Spang Chalfant, Inc.

Chandler Company, Cedar Rapids, Iowa, announces the purchase of the Autocrat Oil Burner Corporation. Manufacture and sale of oil burners will continue under the name of Autocrat Oil Burner Corp., and all operations are to be consolidated in the Chandler Company plant in Cedar Rapids. *C. L. Fontana*, president and general manager of Autocrat, will serve as sales manager of the automatic heating division in charge of oil burner and furnace unit sales.

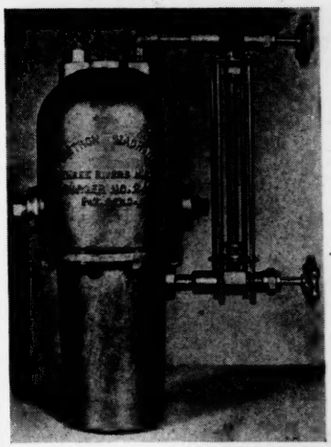
Cochrane Corp., Philadelphia, announces that *Charles M. Chapman* is now its representative on flow meters in the Cincinnati territory covering parts of Ohio, Indiana, and Kentucky, with headquarters at Room 715, Schmidt Building, Cincinnati.

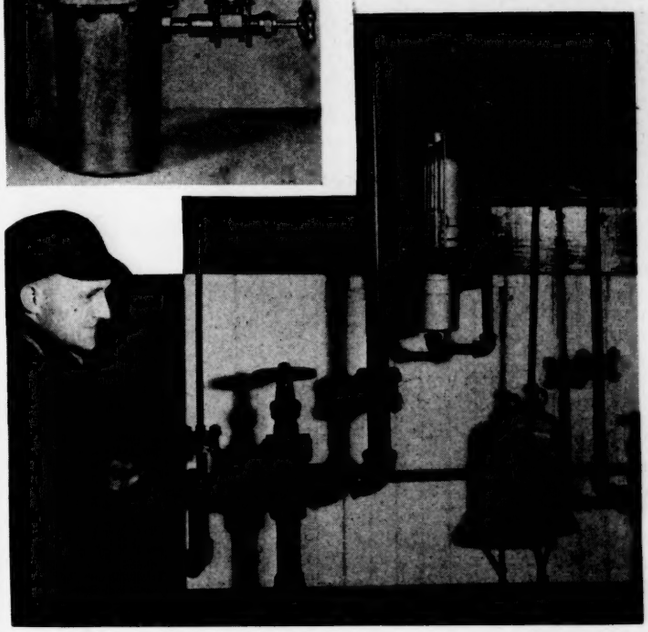
The Hays Corp., Michigan City, Ind., has appointed *Charles M. Chapman* of Cincinnati as its representative covering southern Ohio and contiguous territory in Kentucky and Indiana. Mr. Chapman has established headquarters in the Schmidt Building, Cincinnati.

Maid-O-Mist Inc., Chicago, Ill., announce the appointment of the following representatives: *M. Cerf*, 1210 Tennessee Ave., Cincinnati, Ohio; *George A. Lingo*, 2441 Lockbourn Road, Columbus, Ohio, and *W. J. Hebenstreit*, 5115 Walnut St., Kansas City, Kan.

The Babcock & Wilcox Tube Company, Beaver Falls, Pa., announce the appointment of *Joe S. Thompson* as district sales manager of the Chicago office.

NEW! THE ARMSTRONG PURGER for removing air from refrigerating systems





IF it is part of your job to specify... operate... or install compression type refrigerating equipment, it will be well worth your while to find out about the new Armstrong Purger for removing air and other non-condensible gases from refrigeration systems. Following are a few quick facts:

1 CUTS POWER COST. Records show reductions in head pressure of as much as 45 lbs. and power savings as high as 22% where units are installed.

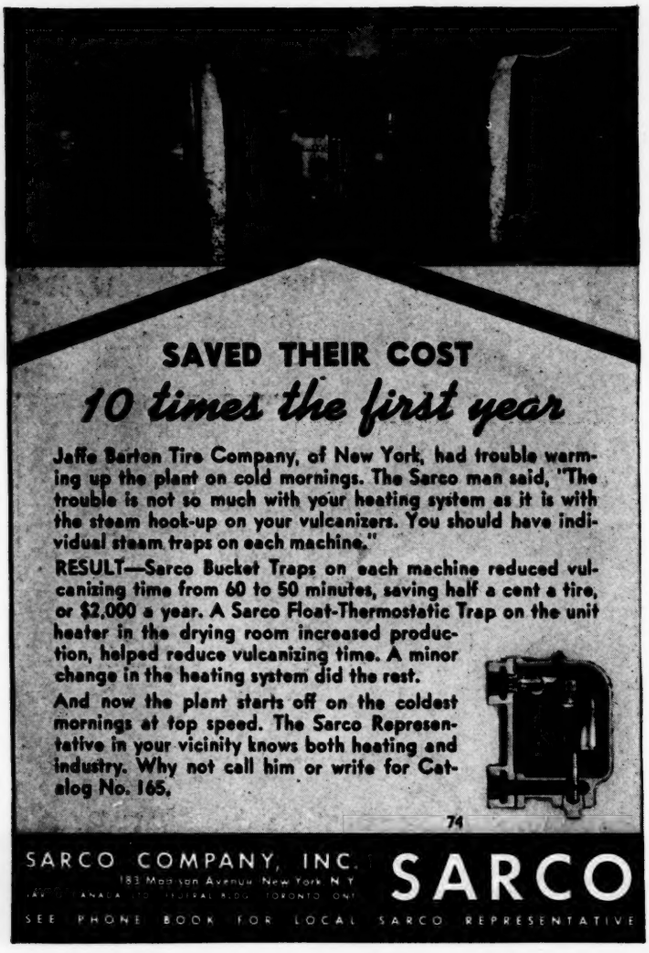
2 INCREASES COMPRESSOR CAPACITY. Every 4 lbs. reduction in head pressure increases compressor capacity approximately 1%.

3 SAVES REFRIGERANT GAS. As compared with wasteful blow-down methods of purging, this new unit reduces loss to a negligible amount.

4 LOW COST. The list price is only $100.00 for a unit that is being used successfully on systems ranging from 12 tons up to 1200 ton capacity.

Write for complete information. New bulletin just off the press. ARMSTRONG MACHINE WORKS, 846 Maple St., Three Rivers, Mich.

The ARMSTRONG PURGER



SAVED THEIR COST

10 times the first year

Jaffe Barton Tire Company, of New York, had trouble warming up the plant on cold mornings. The Sarco man said, "The trouble is not so much with your heating system as it is with the steam hook-up on your vulcanizers. You should have individual steam traps on each machine."

RESULT—Sarco Bucket Traps on each machine reduced vulcanizing time from 60 to 50 minutes, saving half a cent a tire, or $2,000 a year. A Sarco Float-Thermostatic Trap on the unit heater in the drying room increased production, helped reduce vulcanizing time. A minor change in the heating system did the rest.

And now the plant starts off on the coldest mornings at top speed. The Sarco Representative in your vicinity knows both heating and industry. Why not call him or write for Catalog No. 165.

74

SARCO COMPANY, INC.
183 Madison Avenue, New York, N.Y.
SARCO
SEE PHONE BOOK FOR LOCAL SARCO REPRESENTATIVE

Make the first cost the last cost!

Where Somers Hair Spun Glass Filters are installed as original or replacement equipment there's an end to the cost. Somers Filters are washable, odorless, non-absorptive, do not rot, and are practically indestructible.

Dust, dirt, pollen and detritus in the air stream effectively removed with minimum back pressure. No adhesives required.

Somers Filters may be cleaned easily by using the stream from an ordinary water hose (at city pressures) pinched to obtain a spray effect.

SOMERS HAIR GLASS FILTER

For complete details and prices, write giving the c.f.m. per unit and dimensions of present master holding frame. A few choice territories are available for representatives. Full particulars on application.

H. J. SOMERS, INC., 6065 WABASH AVE., DETROIT, MICH.

YARWAY

INVOLUTE **NOZZLES**

The preference for trouble-free air washing service — because there are no internal parts or vanes to wear or clog. Proven through many years of service in water cooling and air conditioning installations totaling more than 5 million g. p. m.

Made in sizes and types for all requirements. Ask for Bulletin N-615.

YARNALL-WARING CO., PHILA.
104 MERMAID AVENUE

Warren Webster & Company, Camden, N. J., announces the addition of *Darragh L. Higgins* to the Radiation and Unit Heater Division of the Company's sales department. Mr. Higgins was with B. F. Sturtevant Company for fourteen years in its plant in Camden and main office in Hyde Park.

The Whitlock Coil Pipe Co., Hartford, Conn., has by vote of the stockholders, changed its corporate name from The Whitlock Coil Pipe Company to The Whitlock Manufacturing Company. The management of the corporation, the character of its organization and its products remain unchanged. The company will continue to manufacture its present lines of heat exchangers, storage water heaters and miscellaneous heaters and will continue its department for the coiling and bending of pipe as heretofore.

York Oil Burner Company, Inc., York, Pa., announce the appointment of *Alonzo W. Ruff* as executive vice president effective March 15.

York Oil Burner Co., Inc., York, Pa., has appointed three new divisional sales managers: *Joseph H. Clark* in the Metropolitan New York area; *Rudolph C. Stolle* in the upper New York territory and *R. R. Kiefer* for the Southeastern seaboard.

Alex L. Frank, formerly divisional sales manager of the Southeastern seaboard territory, has been promoted to take over the management of the wholesale division.

The company recently added a large warehouse to its factory facilities. The addition was the first step taken this year to ease crowded storage conditions.

NEW TRADE LITERATURE

Air Inlets. A standard size, 22-page catalog, No. 31. describing the complete line of Diamond registers and grilles for heating, ventilating and air conditioning applications. Gives information on styles and models available, capacities, dimensions, and list prices. DIAMOND MANUFACTURING CO., INC., WYOMING, PA.

Belting. Standard size, spiral-bound, 24-page catalog on the Chicago Belting Company's line of leather belting. This is a condensed catalog which gives considerable information on leather belting, sizes, prices, and belting applications. CHICAGO BELTING COMPANY, 113-125 No. GREEN ST., CHICAGO, ILL.

Boilers. A special catalog No. 369, on boilers for all fuels, giving the new ratings as approved by the I-B-R —the Institute of Boiler and Radiator Manufacturers. Catalog combines in one publication all pertinent data of product and sales features, ratings and dimensions. Also gives the definition of the basis for new ratings, table of selection factors for high temperature circulating hot water systems and examples of how proper size boilers should be determined. THE NATIONAL RADIATOR COMPANY, 221 CENTRAL AVENUE, JOHNSTOWN, PA.

Boilers. A 4-page, standard size, loose-leaf catalog 99-2a, on the M-8000 series Kewanee Scotch Marine type boiler, designed for low-pressure use and mechanical firing. Gives information on sizes, capacities, and features. KEWANEE BOILER CORPORATION, DIVISION OF AMERICAN RADIATOR AND STANDARD SANITARY CORPORATION, KEWANEE, ILL.

Conduit. A complete catalog No. 40 on the various types of underground steam conduit. Includes large number of cut-a-way illustrations, as well as cross section details and specifications of a wide variety in types of design, insulation, and materials offered for modern approved underground steam construction. Describes and illustrates all necessary accessories, such as, fittings, manhole covers, pipe supports. Presents also alignment guides and engineering data on pipe sizes and combinations, heat loss, insulation efficiency, and other considerations of interest to heating engineers. RIC-WIL COMPANY, CLEVELAND, OHIO.

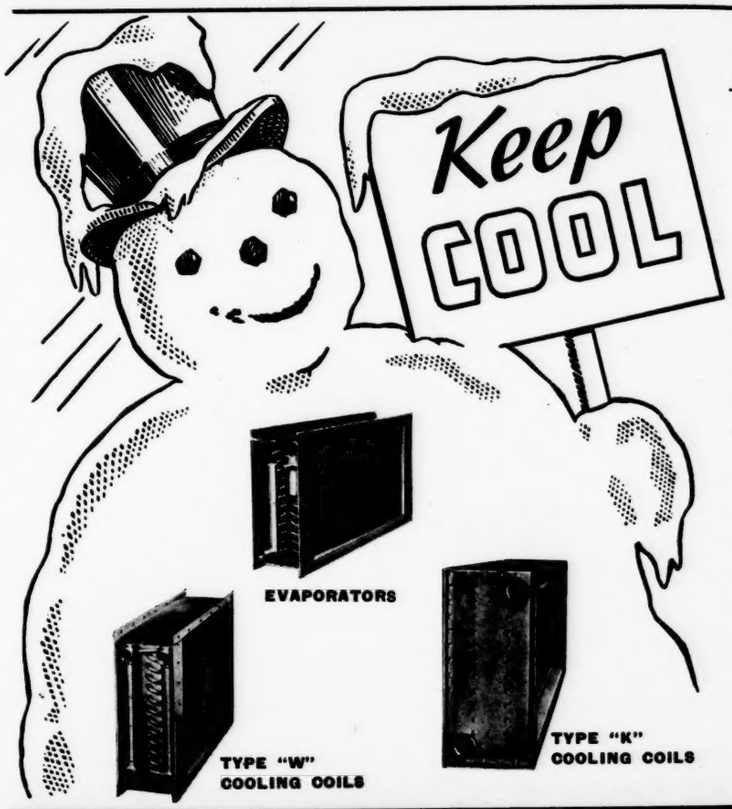
Ducts. A standard size, loose-leaf, 50-page catalog, describing Careyduct asbestos insulated ducts, pipe covering, air conditioning housings and metal duct insulation. The greatest portion of this catalog is devoted to descriptions and illustrations of Careyduct. This section includes considerable information on types of fittings available, method of erection, insulation characteristics, friction losses, sound characteristics, and tables of available sizes. The section on pipe covering gives information on the heat transmission and thicknesses required for various application. Section on air conditioning housings gives information on how this material can be used in air conditioning systems. The metal duct insulation section contains data on thickness required to prevent sweating of metal ducts, also information on specifications and sizes. THE PHILIP CAREY COMPANY, LOCKLAND, CINCINNATI, OHIO.

Electric Heating. A standard size, single page bulletin No. 15, on the Electromode industrial portable electric heaters. Gives information on specifications, dimension, capacity ratings, and features. THE ELECTRIC AIR HEATER CO., DIVISION OF THE AMERICAN FOUNDRY EQUIPMENT COMPANY, 555 BYRKIT ST., MISHAWAKA, INDIANA.

Nozzles. A standard size, loose leaf catalog on Spraying Systems nozzles and nozzle accessories. Includes information on the following type nozzles: Whirljet spray nozzle with removable cap, Whirljet spray nozzle —one-piece cast type, Fulljet, Flatjet, pneumatic atomizers, spray drying, Parasol, Whirljet spray nozzles—angle type, flat atomizing nozzles, roof-cooling nozzles, nozzles for metal cleaning, processing, plating and for industrial washing machines. SPRAYING SYSTEMS CO., 4021 WEST LAKE ST., CHICAGO, ILL.

Odor Adsorbers. Three publications on odor adsorbers. 8-page bulletin No. 105, illustrating and describing Dorex odor adsorbers. Gives information on types available and uses, and shows a number of typical applications. Bulletin No. 106 is a 2-page standard size publication giving detailed information on the type G Dorex odor adsorber for ventilating and air conditioning systems. Bulletin No. 107 is a 2-page publication giving detailed information on the type SQ Dorex odor adsorber, which is a portable, self-contained, circulating unit. W. B. CONNOR ENGINEERING CORP., DOREX DIVISION, 114 EAST 32ND ST., NEW YORK, N. Y.

Traps. A standard size, 16-page bulletin T-1735, on the Yarway Impulse Steam Trap. Gives information on outstanding features, construction, operating principles, method of selection, installation and operation, capacities, sizes and prices. Also includes a section on how to determine steam trap efficiency. YARNALL-WARING COMPANY, CHESTNUT HILL, PHILADELPHIA, PA.



DO THE JOB RIGHT

with YOUNG Coils and Evaporators

Young cooling coils and direct expansion evaporators enable the architect, engineer and contractor to plan or handle any air conditioning job, whether the refrigerating medium is water, brine, Freon or Methyl Chloride.

Built to controlled standards of quality assuring the utmost efficiency and durability, Young coils cover the entire field and are available in all sizes and capacities.

Conservative ratings based upon accurate performance data obtained by thorough tests are given in catalogs which will be sent upon request or may be secured from your regional Young sales representative, who will gladly discuss your requirements with you without cost or obligation.

YOUNG RADIATOR COMPANY
RACINE WISCONSIN

Young Quality

MARLO
EVAPORATIVE REFRIGERATION
CONDENSERS

Complete self-contained combination forced draft Cooling Tower and Condenser. Outdoor or indoor installation.

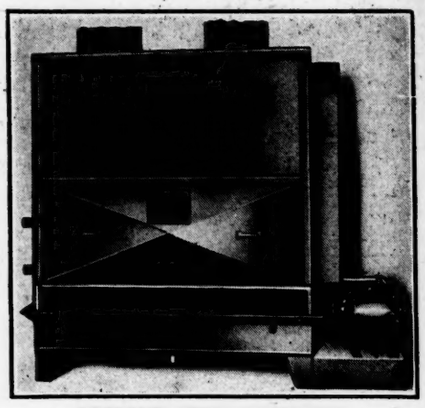
Particularly desirable in localities where water rates are high, ordinances restrictive, or drainage systems limited, because—

Marlo Evaporative Condensers *save about 95% of water required for ordinary condensers* which take water from city mains and waste it.

One-ton capacity and up.

Write for new Bulletin No. 394 giving full details, specifications and prices.

MARLO COIL CO., 6135 Manchester Ave., St. Louis, Mo.



REFRIGERATION EQUIPMENT MANUFACTURERS W-3

Serving Baltimore's Tallest
Carey 85% MAGNESIA and Air Cell Asbestos

Baltimore's thirty-four story home of The Baltimore Trust Company has a business population of over 3,000 persons. Their heating and hot water comfort is safeguarded by Carey 85% Magnesia Insulation. The efficiency of the air conditioning system for the banking floors is maintained by use of Carey Air Cell Insulation.

CAREY experience, research facilities and a complete line of insulations are at your service for any building project. Write to Department 49 for information.

THE PHILIP CAREY COMPANY • Lockland, Cincinnati, Ohio
Dependable Products Since 1873
BRANCHES IN PRINCIPAL CITIES

Prompt Shipment!
E-Z RADIATOR HANGERS

Orders shipped on date of receipt regardless of quantities. Used by leading architects, contractors and U. S. Government. Quick easy installation. Adjustable horizontally and vertically.

A Style for Every Situation
Write for Details

HEALY-RUFF COMPANY, 815 Hampden Ave.
ST. PAUL MINNESOTA

Also Manufacturers of E-Z Concrete Inserts

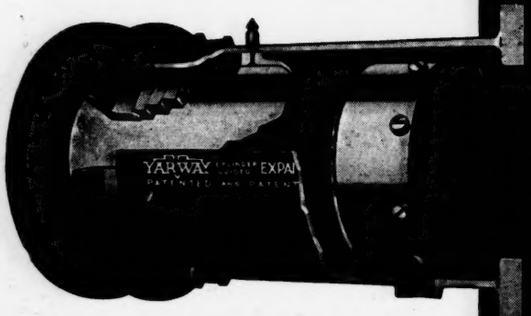
NON-CLOGGING SPRAY NOZZLES
ALL SIZES ALL TYPES ALL CAPACITIES *for* Air Conditioning

A complete line of nozzles for air conditioning and industrial use. Write today for new catalog, data and application sheets and price list.

SEND FOR CATALOG AND DATA SHEETS

SPRAYING SYSTEMS CO.
4031 W. LAKE ST. • CHICAGO

CYLINDER-GUIDED FOR TROUBLE-FREE SERVICE



Made in single or double end types with or without base.

YARWAY
EXPANSION JOINTS

Welded Steel construction. Alemite lubrication. Diameter no larger than pipe flange . . . Outside cylinder guide design prevents abrasive sediment from cutting the sleeve. Write for catalog EJ-1904, which describes both Gland-Pakt and revolutionary Gun-Pakt (packed under pressure) types.

YARNALL WARING COMPANY, Philadelphia
104 MERMAID AVENUE